THREE ESSAYS IN APPLIED REGIONAL WELFARE ANALYSIS:

THE EFFECT OF EDUCATION ATTAINMENT AND LOCAL INTERACTION ON WEALTH INEQUALITY IN A SPATIAL ECONOMY,

TIME INCLUSION IN STRUCTURAL PATH ANALYSIS, AND

AN ECONOMETRIC EXAMINATION OF IMPACTS OF MONETARY POLICY ON THE WELFARE OF DIFFERENT INCOME GROUPS

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The first essay (Chapter 1) explores the importance of spatial interactions in an overlapping generation model using an Agent-Based Model (ABM) approach. Incorporating geography into the original Galor-Zeira's model (1993) and allowing heterogeneous agents to interact locally, we show that social interactions play an important role in determining the long-run welfare and wealth distribution. This model shows the impact of endogenous wages and local interactions on agents' decision to invest in human capital. Our simulation reveals that neighborhood interactions lead to changes in the system's steady-state behaviors. In particular different strength of agents' interaction produces different outcomes in terms of the number of educated people and wealth inequality. This might explain persistent inequality in agents' wealth across locations. Policy implications are discussed.

The second essay (Chapter 2) introduces the time elements of structural path analysis (SPA). Structural path analysis, which was first introduced by Defourny and

Thorbecke (1984), broke down the global multipliers of the social accounting matrix (SAM) into direct influence and total influence. The introduction of time elements into SPA has enabled policymakers to estimate the range of time required for a shock to travel from its origin to its destination. Using the 2008 Indonesian SAM with a focus on the agricultural and manufacturing sectors, this study successfully introduces time into the SPA framework and estimates the possible time range within which a shock from the agricultural and manufacturing sectors will impact different households.

The third essay (Chapter 3) explores impacts of monetary policy on the welfare of people in different income groups in Indonesia with a dynamic demand system. In the model, income groups adjust their expenditures shares in response to changes in commodity prices and aggregate expenditure levels. These adjustments are taken to be functions of the rate of change in the flow of financial services, which is affected by the rate of growth of the money supply (M2). Results of model estimation and deterministic numerical simulations conducted with the estimated model suggest that the welfare of the low-income group is affected more by monetary policy than is the welfare of the high-income group.

BIOGRAPHICAL SKETCH

Gunawan Wicaksono was born on September 8^{th}, 1969 in Banjarmasin, Kalimantan (Borneo), Indonesia. He moved to Jakarta, the Indonesian capital, when he was four years old due to a serious illness that required intensive treatment. Only by the grace of G-d, was he completely healed. In 1988, he began his study in Industrial Engineering (which at that time was still under Mechanical Engineering) in the University of Indonesia. After earning his BA degree in Industrial Engineering in 1993, he worked for a short time in a big timber company in Indonesia and became involved in the training division where he conducted training in Total Quality Control and Management (TQC/TQM).

Due to his expertise in TQC/TQM, he was hired by the Indonesian Central Bank, Bank Indonesia (BI), where he began his career as a junior officer in 1994 in the training and education department. With good knowledge in mathematics, he took an opportunity offered by BI to pursue a Master degree in Economics in 1997 in Claremont Graduate University, California. In 1999, He received his Master in Economics with an excellent GPA and joined the faculty of the Statistics Department at BI, where he was then promoted in 2000 to be an economist's assistant. In 2001, through his initiative and creativity, he initiated the first effort to calculate Indonesian Capital Stock by arranging a joint-coordination of BI and Indonesian Bureau Statistics (BPS). He also improved the methodology used to calculate the Indonesian banking value-added used for GDP calculation. In 2003, he also initiated a joint-project with BPS to launch an effort to compute the first Indonesian Financial Social Accounting Matrix officially under the supervision by Prof. Iwan J. Azis from Cornell University. In 2005 the project was then continued by his successor when he was promoted to the role of senior economist.

Following Prof. Azis's advice, he then chose to continue his studies in pursuit of a PhD in Regional Science at Cornell University in 2007. There, he developed his expertise in system dynamics, computational general equilibrium, decision analysis using analytical hierarchical project (AHP) and analytical network process (ANP), dynamic econometrics, agent-based modeling and input-output and social accounting matrix framework. Under the supervision of Prof. Kieran Donaghy, Prof. Erik Thorbecke and Prof. Yuri Mansury, he successfully defended his dissertation in June 2013 and received his PhD degree in August 2013. Starting in the fall of 2013, he will be working at Harvard as an Indonesian research fellow.

To My Beloved Father YHWH in Yahshua Hamashiach,

my beloved wife Elsa, my beloved children

Gianina, Gavrila, Geneustace,

my beloved parents and my parents in law

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LIST OF ABBREVIATIONS

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ABM	Agent-Based Model
TD	Threshold of Decision
Ws	Skilled Worker
Wn	Unskilled Worker

Chapter 2: Time Inclusion in Structural Path Analysis with a Case Study of the 2008 Indonesian SAM

HH	Households
AgWRu	Agriculture receiver of wages and salaries rural
AgWUr	Agriculture receiver of wages and salaries urban
AgNWRu	Agriculture not receiver of wages and salaries rural
AgNWUr	Agriculture not receiver of wages and salaries urban
PrWRu	Production receiver of wages and salaries rural
PrWUr	Production receiver of wages and salaries urban
PrNWRu	Production not receiver of wages and salaries rural
PrNWUr	Production not receiver of wages and salaries urban
AdWRu	Administration, Sales, Services receiver of wages and salaries rural
AdWUr	Administration, Sales, Services receiver of wages and salaries urban
AdNWRu	Administration, Sales, Services not receiver of wages and salaries rural

AdNWUr	Administration, Sales, Services not receiver of wages and salaries urban
MgWRu	Leaderships, Management, Military, Professional and technicians receiver of wages and salaries rural
MgWUr	Leaderships, Management, Military, Professional and technicians receiver of wages and salaries urban
MgNWRu	Leaderships, Management, Military, Professional and technicians not receiver of wages and salaries rural
MgNWUr	Leaderships, Management, Military, Professional and technicians not receiver of wages and salaries urban
CAP	Not Labor Force
FarmL	Farm workers
FarmEn	Farm entrepreneurs
LoEnRu	Low entrepreneurs rural
NLFRu	Not a labor force and unclear workers classification rural
HiEnRu	High entrepreneurs rural
LoEnUr	Low entrepreneurs urban
NLFUr	Not a labor force and unclear workers classification urban
HiEnUr	High entrepreneurs urban
Ent	Enterprises
Gov	Government
SAgCrop	Sector of agricultural crops
SAgLivSt	Sector of agricultural livestocks and produce
SAgFish	Sector of agricultural fishery
SAgInd	Sector of agricultural food industries, beverages and tobaccos
SAgOth	Sector of agricultural other crops

SForest	Sector of forestry and hunts
SMinOil	Sector of coal and metal ore mining, oil and gas mining
SMinOth	Sector of other mining and quarrying
SChemMet	Sector of chemical industry, fertilizer, clay products and cement and basic metal industry
SGovSos	Sector of government and defense, education, health, other social services, film and entertainments
SIndServ	Sector of individual services, households and other services

Chapter 3: An Econometric Examination of Impacts of Monetary Policy on the Welfare Of Different Income Groups In Indonesia Using A Dynamic Demand System Approach

slf	Shares of low-income households' expenditure on food
slh	Shares of low-income households' expenditure on housing
Slo	Shares of low-income households' expenditure on others
Suf	Shares of high-income households' expenditure on food
Suh	Shares of high-income households' expenditure on housing
Suo	Shares of high-income households' expenditure on others
Dx	Change of variable x with respect to time
DUlo	Change of welfare of low-income groups
DUhi	Change of welfare of high-income groups
ln x	Logarithmic natural of variable x
M	Money supply (here we use currency in circulation)
VDFLS	Change of the flow of the financial services

LIST OF SYMBOLS

Chapter 1: The Effect of Education Attainment and Local Interactions Toward Wealth Inequality within Overlapping Generations in A Spatial Economy

Symbols	Explanation
w_n	Unskilled-worker wages
w_s	Skilled-worker wages
P	Price of commodity
M	Agent's lifetime earning
h	Education cost or human capital investment cost
x	Agent's Inheritance
c	Agent's Consumption
b	Agent's Bequest
θ	Agent's strength of interaction
π	Agent's tendency to invest in human capital
ξ	Subsidy parameter
r	Deposit interest rate
i	Loan interest rate
β	Parameter connecting loan and deposit rate
τ	Share parameters in Cobb-Douglas production function
α	Agent's consumption share
TD	Agent's minimum number of neighbors to decide to invest in education
Subscript i	Indicating specific agent i

Chapter 2: Time Inclusion in Structural Path Analysis with A Case Study of 2008 Indonesian SAM

Symbols	Explanation
$I^D_{(i,k,j)}$	Direct influence through the path of $i \rightarrow k \rightarrow j$
$I^T_{(i,k,j)}$	Total influence through the path of $i \rightarrow k \rightarrow j$
$p_{(i,k,j)}$	Path multipliers through the path of $i \rightarrow k \rightarrow j$
X	The size of input to the initial pole
a_{ji}	Marginal expenditure from pole i to pole j
I^G_{ji}	Global influence from pole i to pole j
v_{ji}	Flexible time transformation speed from pole i to pole j
$t_{v\,ji}$	Flexible-time transformation from pole i to pole j
$t_{f\,ji}$	Fixed-time transformation from pole i to pole j
$t_{i\rightarrow k\rightarrow j}$	Time required for influence to travel through the path of $i \rightarrow k \rightarrow j$
$t_{(i,k,j)}$	Time required for influence to travel through the path of $i \rightarrow k \rightarrow j$, the same as notation $t_{i\rightarrow k\rightarrow j}$
t_{ji}	Time required from pole i to pole j
i	Effective interest rate
r	Annual interest rate
APC	Average propensity to consume (average expenditure to consume)
MPC	Marginal expenditure to consume (marginal expenditure to consume)
ε	Expenditure elasticity
e^x	Exponent of x
m	Multiplicative factor in a sum of convergent series

Chapter 3: An Econometric Examination of Impacts of Monetary Policy on the Welfare of Different Income Groups in Indonesia using A Dynamic Demand System

Symbols	Explanation
ρ^i	Parameter of substitution of income group i
ϕ_j^i	Share parameter of j^{th} commodity price with i^{th} income group.
β_j^i	The contribution of j^{th} commodity toward parameter η for each income group.
η^i	The degree of homogeneity of the price aggregator of the i^{th} income group.
γ_{jk}^i	Parameter of adjustment of j^{th}commodity related to k^{th}commodity for i^{th} income group.
γ_{jf}^i	Parameter of adjustment of j^{th}commodity related to the financial services for i^{th} income group.
γ_6	Parameter of adjustment for the money supply
β_1	Parameter of adjustment of the real GDP
β_2	Parameter of the benchmark interest rates.
p_j	Price of j^{th}commodity
s_k^i	Share of k^{th}commodity toward the consumption of the i^{th} income group.
CC	Currency in circulation
CA	Current account (checking accounts)
QM	Quasi money (savings accounts)
i_b	Benchmark interest rates, here is loan interest rates
i_{ca}	Current account interest rates, we use BI rates
i_{qm}	Savings interest rates, we use the average savings rates

P	GDP deflators
Y	Real GDP in constant rupiahs.
C^i	Consumption by income group i
E_j^i	Expenditure elasticities of demand of income group i
M_{jk}^i	Price elasticities of demand for commodity j of income group i by the change of the price p_k.

PREFACE

This dissertation book seeks to raise up two issues regarding the income inequality and one issue regarding the improvement of methodology. In the first chapter, we employ an agent-based model to Galor-Zeira's 1993 model of education attainment and income inequality by adding local interactions between heterogeneous agents within a two-dimensional space. It is quite interesting to observe how simulations with local interactions show different results than that which excludes local interactions. It demonstrates how the local interactions and space play an important role in determining the number of skilled workers in the economy and thus the economic growth of the region.

In the second chapter, we tried to add time elements to Defourny and Thorbecke's 1984 structural path analysis. This methodology is then applied to a case of shock transmission from the agricultural crop sector and the chemical and metallic sector to different household groups based on the 2008 Indonesian Social Accounting Matrix. This exercise shows that the receivers would receive the impacts within some periods of time in which most of the influences are transmitted. Some paths containing a fixed schedule of transmission might significantly delay the transmission of the shocks and thus reducing the present values of the impacts received.

In the third chapter, we use econometrics to explore how different income groups, namely high- and low- income groups, react differently toward changes in monetary policy. Employing a dynamic demand system with non-homothetic preferences enabled us to observe the households' reactions to adjustments their expenditures shares in response to changes in commodity prices and aggregate expenditure levels. The results suggest that the welfare of the low-income group is affected more than that of the high-income group by monetary policy changes.

CHAPTER 1

THE EFFECT OF EDUCATION ATTAINMENT AND LOCAL INTERACTIONS ON WEALTH INEQUALITY WITHIN OVERLAPPING GENERATIONS IN A SPATIAL ECONOMY

1.1. Introduction

One of the main tasks of regional scientists is to explain spatial inequality as an outcome of a decentralized process, and to understand the human behavior that leads to uneven patterns. This chapter examines how local interactions affect human capital investments and the distribution of wealth in a decentralized economy. The analysis is based on Galor and Zeira (1993)'s overlapping generation model with indivisible investments in human capital designed to study the role of historical dependence in generating persistent wealth inequalities.

How do human interactions in space affect the distribution of wealth? Drawing on the framework of complex systems studies, we propose an agent-based model where adaptive individuals change their attitude toward education as they interact with local neighbors. The role of local interactions and neighborhood feedbacks in changing economic stratification has been explored before. Previous studies, however, usually emphasize *income* inequality and often neglect the role of inter-generational transfers (e.g., Durlauf, 1996), or utilize space in a very abstract sense (e.g., Benabou, 1996).

This chapter seeks to make modest contributions to the literature. First, as far as we know, ours is the first attempt to explore the impact of *local interactions* on wealth inequality in an agent-based model with inter-generational transfers. We do so by implementing a general equilibrium model with known analytical solutions, thus allowing the benchmark agent-based simulations to be validated (i.e., "structural validation"). We then investigate how aggregate economic performance and inequality change as a result of changes in the extent of local interactions. Finally, we show that neighborhood effects impinge on the efficacy of policies that aim to generate an equitable distribution of wealth.

1.2. Literature Review

Conventional wisdom views wealth inequality as an outcome of either unequal inheritance or labor market choices (i.e., the decision to work in industries that require certain skills but reward higher pay). Thus Piketty (2011) argues that employment and inheritance are substitutes in that one can become wealthy either by working hard or by marrying somebody with a large family inheritance. It can be argued, however, that inheritance *complements* labor market outcomes when access to good jobs depends on the kind of educational achievements that only the wealthy can afford. This is the view that we espouse in this chapter.

Our analytical framework extends Galor and Zeira (1993)'s overlapping generation model of human capital investments. An overlapping generation model, as Samuelson (1958) introduced, describes a demographic structure where parents and offspring live together in one (or more) period. Parents then die at the end of the shared period, while the youth live on to the next period and beget their own children before they, too, die. Inter-generational transfers occur during the time together, motivated by the parents' desire to secure a better future for offspring. The dynamic then repeats with a different, younger set of agents in perpetuity.

Galor and Zeira (1993) show how the ancestry distribution of endowments coupled with costly investments in human capital can produce a bipolar distribution of wealth. The main message is that the poor and the rich can continue to co-exist even in the very long-run if the initial distribution is sufficiently heterogeneous. To this general equilibrium model we add geography, which allows us to focus on the role of local interactions in perpetuating the inequality between poor and rich *neighborhoods*.

Numerous studies have documented the relationship between human capital and economic status. The notion of human capital investments as a source of inequality was originally formalized by Mincer (1958), and developed further by Becker (1964). Since then, it has been the tradition in labor economics to describe the diversity of individual earnings as a function of schooling.[1] The micro-level empirics are generally consistent with the macro-level data. Nomura (2007) for example shows using cross-country data that initially the poor benefit the most from education in terms of the improvement in living standards. Imperfect capital markets, however, curtails the poor's ability to invest in education, and this preserves, if not worsens, aggregate inequality. This strand of human capital literature, however, rarely links economy-wide inequality to *spatial* patterns.

It is the studies on agglomeration economies (Rosenthal and Strange, 2001) that produce evidence of the tendency for skilled workers to cluster in cities. The starting point of this research is the hypothesis that the interactions of skilled workers–a proxy

[1] See the extensive survey in Card (1999).

for the stock of human capital–in a crowded urban environment increase everybody's returns to education, which in turn attracts even more skilled workers. That is, there is something about local interactions in close proximity that promote the accumulation of human capital. The econometric analyses generally support this hypothesis (e.g., Glaeser and Mare, 2001; Moretti, 2004). At about the same time, the creative class literature that Florida (2002, 2008) champions received a lot of attention in the popular media because of its socio-economic implications. In *Who's Your City* for example, Florida refers to the growing geographical divide between skilled workers and the rest of society. The segregation is inevitable, asserts Florida, because of the need for skilled workers to cluster in order to become more productive, and in so doing powers economic growth. Compelling as it is, however, the creative class literature is generally silent about the role of initial wealth in generating spatial inequality.

Nakajima and Nakamura (2009) show that the inability of the poor to invest in education aggravates inequality further. Initially, diminishing returns allow the poor to reap most of the benefits of education and improve their wealth, both in absolute terms and in relation to the rich. Over time, however, demand pressures cause the price of schooling to rise, leading to an outcome where only the rich can afford to invest in education. Unequal access to human capital investments then creates a persistent gap between the rich and the poor (Andergassen and Nardini, 2007). Only by lowering education costs—presumably through government subsidies—can inequality diminish in the long run.

Inter-generational transfers come into play when the ability to finance children's schooling depends on the parents' wealth. Das (2007) shows that descendants of the poor are more likely to stay in poverty than the offspring of the rich. The key insight here is that initial wealth distribution determines future distribution through transfers from the older generation to the next, which may include both inheritance and gifts (e.g., the parents' "purchase" of their offspring's education). Rich parents leave large bequests in order to secure their descendants' future, while the poor's inability to invest in their children's education prevent their children from moving to the higher income stratum. It is this parents' feeling of insecurity about their children's future that motivate the transfer of wealth to the children (Fan, 2006).

Equal opportunity to education alone, however, does not guarantee an egalitarian distribution of wealth. Social milieu also matters. Bowles, Loury and Sethi (2010) show that voluntary segregation in social networks causes persistent inequality. That is, segregation by class (e.g., the rich interacting only with the rich) increases the likelihood for the poor to remain trapped in poverty. The role of neighborhood local interactions is examined by Mookherjee et al. (2010a, 2010b), which advances a theoretical model showing the role of the educated in inspiring others in the neighborhood to also invest in education. The theoretical importance of neighborhood effects has been confirmed by empirical studies. Corcoran et al. (1989) for example found the link between community characteristics and offspring future economic status. Further, Stewart et al. (2007) reveals the impact of neighborhood composition on the educational aspirations of younger generations.

The empirics motivate the present study to introduce agent heterogeneity and direct interactions to the general-equilibrium framework of Galor and Zeira (1993). In many previous studies of wealth inequality, space is often represented by a single parameter designed to capture the extent of local interactions. The present study distinguishes itself from these studies in proposing a spatially-explicit model where agents are situated in a two-dimensional grid lattice. Heterogeneity implies agents making different education choices initially. Direct interactions with neighbors, however, allow agents to observe the education prospects of neighbors in the vicinity. Based on pure economic calculations (i.e., without taking social influences into account), agents observe the peers to whom human capital investments would be a viable option. If there are sufficient prospects around, agents may be persuaded to adapt in order to conform to the social milieu. Adaptations then occur when agents imitate their neighbors and make a different choice.

The introduction of space and local interactions agents renders the equilibrium distribution of wealth analytically intractable. Simulations are thus the only resort. It is to simulate the emerging spatial patterns of production and inequality in a decentralized economy that we exposit an agent-based model.[2] Computational models have been used to explain emerging patterns in urban and regional systems with heterogeneous agents (Mansury and Gulyas, 2007; Parker and Filatova, 2008). Here we present a new bottom-up approach showing how results change depending upon the degree of local interactions and neighborhood effects.

The rest of the chapter proceeds as follows. The next section lays out the analytical framework for the numerical simulations. Following that, Section (1.3) details the

[2] ABM is also known as Agent-based Computational Economics (ACE) (Tesfatsion, 2005). Tesfatsion stressed the importance of ACE in dealing with complicated micro behavior in real world (etc. asymmetric information, imperfect information and multiple equilibria).

mathematical model and implementation of the agent-based algorithm with endogenous skilled workers. It also outlines the various scenarios that we consider in this chapter, and Section (1.4) reports the simulation results. We close in Section (1.5) with concluding remarks and suggestions for future research direction.

1.3. Model

1.3.1. Mathematical Model

The model extends Galor and Zeira (1993) with important differences in several respects. First, our agent-based model is numerical and spatial, and it treats workers and capital as discrete variables. In addition, we allow neighboring agents to interact directly, which is the main value-added of agent-based simulations where geography matters. Last but not least, we explicitly model the skilled labor market, allowing skilled-worker wages to be endogenously determined. The numerical implementation of the agent-based model is detailed in the next sub section (1.3.2). This section describes mathematically the micro-foundations of production, human capital investments, and workers behavior.

We begin by reviewing the canonical model of Galor and Zeira (1993), which combines continuous variables (i.e. labor and capital) with indivisible human capital investments in a discreet time within an overlapping generation model where every agent lives for two periods. Young agents have to choose between working as an unskilled (uneducated) worker and foregoing work in order to attain education. It is assumed that only by acquiring education when they were young would agents be able to work as skilled workers in the second period of their life. The production economy employs both types of workers—though at different sectors—, namely skilled and unskilled worker sectors $= \{s, n\}$, in order to supply output. The economy produces a single commodity, which is consumed by old agents, who also give birth to the next generation of agents, exactly one offspring per parent. Having given birth, parents give bequest to their descendants, and consume the remaining wealth. This cycle continues indefinitely.

Each sector utilizes a distinct recipe in manufacturing output. Specifically, the production recipe for the sector employing unskilled workers is linear:

$$Y_n = \emptyset\, L_n, \tag{1.3.1.1}$$

where $\emptyset$ is the sector's constant marginal product of labor (MPL), and L_n the number of unskilled workers employed. By contrast, the production function for the skilled labor sector is using a Cobb-Douglas production function:

$$Y_s = A\, K_s^{\tau}\, L_s^{1-\tau} \tag{1.3.1.2}$$

where K_s denotes the physical capital, L_s the number of skilled workers, A the technological constant, and τ the share parameter. These two recipes produce the same homogenous commodity, to be consumed by utility maximizing agents in the second period of their life. Note that an alternative medium of exchange needs to be identified since the model focuses on a non-monetized economy. We simply assume here that agents agree to set the consumption good as a *numeraire* and, without loss of generality, fix its price $P = 1$.

Two major assumptions in the model are indivisibility of human capital investment and imperfect capital market. Education indivisibility instigates people with choices of either endow part of their income for schooling and work as skilled labor or just work as unskilled labor. Agents only live for two periods of time and the choice of schooling is made in the first period of their lifetime. The stream of income consists of wages and bequest and is consumed all in the second period of the lifetime after leaving aside inheritance for the next generation.

We depart from Galor and Zeira (1993) by introducing direct interactions, which allow local neighbors to influence agents' human capital choices. Young agents observe their local neighbors' prospects for education based solely on economic ground, which agents take into account in making allocation decisions. We assume a simple rule of engagement where a weighted average is calculated to capture the agent i's tendency to invest in human capital:

$$\pi_i = \theta\varphi_{-i} + (1-\theta)\varphi_i \qquad (1.3.1.3)$$

where $0 \leq \theta \leq 1$ is the weight for neighborhood effects, φ_i is based on the agent's internal economic calculations (= 1 if education is economically viable, 0 otherwise), and φ_{-i} is based on the neighbors' economic prospects. Equation (1.3.1.3) is inspired by Wilson (1987), which has documented the persistent under-investments in human capital among the poor isolated in inner city neighborhoods. Here educational choices depend on whether π_i exceeds a critical level (and exogenously given) $\pi_{\min}$ which, if surpassed, will lead to agents investing in human capital. The exception of this rule is when wealth falls below zero because local interactions persuade agents to invest in education that they could not afford. In this case, agents revert back to the default choice of working as an unskilled worker in both periods of their lives.

Agents consume only in the second period of their life. The satisfaction that agents get from consumption (and bequest) is described by a log-linear utility function (Galor and Zeira, 1993):

$$U_i(c_i, b_i) = \alpha \ln c_i + (1 - \alpha) \ln b_i \quad (1.3.1.4)$$

where c_i and b_i denote agent i's consumption and bequest, both in terms of the aggregate commodity, and $0 < \alpha < 1$ the share parameter. Agents are rational in the sense that they choose the division of wealth between consumption and bequest that maximizes welfare. The log-linear formulation implies that agents allocate a fixed proportion α of their lifetime wealth M (defined below) to own-consumption, and leave the rest for their offspring.

The lifetime wealth of an agent depends on its skills, as well as on whether the agent borrows to finance education. Agents who opt out of education would then work as unskilled workers in the two periods of their lives and earn:

$$M_i = (1 + r)(x_i + w_n) + w_n \quad (1.3.1.5)$$

where w_n denotes the wages for unskilled workers, x the inheritance they receive from their parents, and r the interest rate on the first-period's savings. That is, since agents consume only in period 2, they save the wages, w_n, earned and bequests, x_i, inherited in period 1, which would then yield interests that become available in period 2.

On the other hand, those who choose to invest in human capital and can afford to self-finance their education would have lifetime wealth as follows:

$$M_i = (1 + r)(x_i - h\ ) + w_s \ \ for \ \ \geq h \qquad (1.3.1.6)$$

where h denotes the cost of education, and w_s the market-determined wages for skilled workers. The idea here is that agents forgo work when they are young in order to acquire skills, and their inheritance, x_i, is large enough that they can afford the cost of education, h, without borrowing from the financial market. The acquired skills would then allow educated agents to earn a wage, $w_s \gg \ w_n$, that is significantly higher than for unskilled employment.

The third type of agents correspond to those with small inheritance that—should they invest in human capital—they would have to borrow in order to finance their education. This is simply because the cost of education exceeds their inheritance. Their lifetime wealth as skilled workers then would be as follows:

$$M_i = (1 + i)(x_i - h\ ) + w_s \qquad (1.3.1.7)$$

where i is the interest rates on the loan, $x_i - h$, that borrowing agents would have to repay in period 2. For this choice to be financially viable, skilled workers must earn a large enough wage, w_s, in order to create wealth exceeding that of unskilled workers receiving the lower wages, albeit in two periods.

Since agents are rational and utility maximizing, they make choices (i.e., whether to invest in human capital or not) that yield the highest lifetime wealth M_i. Having made education choices, agents then decide how to split wealth between own consumption and bequests. It can be shown the log-linear utility function implies that the optimal bequest and consumption—based solely on economic calculations—would be:

$$b_i(x) = (1 - \alpha)M_i,$$

$$c_i(x) = \alpha M_i \quad (1.3.1.8)$$

In this case, following Equation (1.3.1.8), we would have the optimized utility of unskilled labor is determined from maximization of Cobb Douglas utility function subject to the budget constraint. The bequest of unskilled labor (b_i^n) and skilled labor (b_i^s) is computed as in the following; for the unskilled labor's bequest (1.3.1.9a), the skilled labor with bequest greater than education cost (1.3.1.9b) and the skilled labor with bequest less than education cost (1.3.1.9c) (Galor & Zeira, p.39):

$$b_i^n(x_i) = (1-\alpha)[(1+r)(x_i+w_n)+w_n];$$

$$c_i^n(x_i) = \alpha[(1+r)(x_i+w_n)+w_n] \quad (1.3.1.9a)$$

$$b_i^s(x_i) = (1-\alpha)[w_s+(x_i-h)(1+r)];$$

$$c_i^s(x_i) = \alpha[w_s+(x_i-h)(1+r)] \quad (1.3.1.9b)$$

$$b_i^s(x_i) = (1-\alpha)[w_s+(x_i-h)(1+i)];$$

$$c_i^s(x_i) = \alpha[w_s+(x_i-h)(1+i)] \quad (1.3.1.9c)$$

The relationship of borrowing rate and deposit rate is the following (Galor & Zeira, p.39):

$$i = \frac{1+\beta r}{\beta-1} \quad (1.3.1.10)$$

with $\beta > 1$ to make borrowing rate greater than zero.

Galor and Zeira shows that when individuals who inherit more than f but less than g will invest in human capital and work as skilled labors but after several generations, they will all back to unskilled labors and back to $\overline{x}_n$. Individuals who inherit more than g will invest in human capital generations after generations and will end up in $\overline{x}_s$. The value of f and g are determined respectively by the following equations (Galor & Zeira, p.41, 44)[3]:

$$f = \frac{w_n(2+r)+h(1+i)-w_s}{i-r}$$

$$g = \frac{(1-\alpha)[w_s - h(1+i)]}{[1-(1-\alpha)(1+i)]} \tag{1.3.1.11}$$

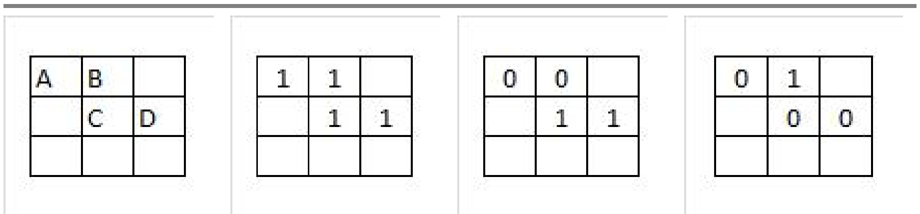
When we add space into the model, how do local interactions affect education decisions? The spatial structure of our model corresponds to a two dimensional grid lattice, where every agent is surrounded by and interacts with at most eight adjacent neighbors (the so-called *Moore neighborhood*). Given this structure, the decision whether to invest in human capital depends on (i) the neighborhood composition and (ii) the strength of local interactions. Thus, for example, when interactions strength is maximum, $\theta = 1$, then education decisions depend exclusively on the neighbors' economic prospects according to the calculations in Equations (1.3.1.5) – (1.3.1.7). Furthermore, if there are enough prospects to persuade an agent — more than the threshold *TD* — then the agent would pursue education, as long as it results in a positive lifetime wealth. Note the *bounded rationality* inherent in agents making choices based on the neighbors' prospects—i.e., without knowing what the neighbors would ultimately decide to do. This may be interpreted as agents anticipating peers to

[3] The point f is determined from equating the bequest of the skilled workers to that of the unskilled ones: $(1-\alpha)[(1+i)(f-h)+w_s] = (1-\alpha)[(f+w_n)(1+r)+w_n]$ and solve it for f. The critical point g is determined from the intersection of the bequest of the skilled workers $b_s(x)$ and 45 degree line when $f \leq g \leq h$: and then solving it for g.

receive significant inheritance from their well-to-do parents. But some candidates for education would opt out of school if interactions are strong *and* there are not sufficient prospects in *their* neighborhood. Our model assumes that agents lack the wherewithal to foresee their neighbors' *actual* decisions.

For concreteness, consider once again the maximum dependency ($\theta = 1$) example where, in addition, agents need to be persuaded by at least two prospective neighbors (*TD* = 2) in order to pursue education. Now consider agent C who has three neighbors, A, B, and D (see panel (i) in Fig. 1.3.1.1). Let "type 1" agents be those for which a skilled job yields wealth higher than unskilled employment, and let "type 0" be the opposite. Suppose the economic calculations are such that education is feasible for everybody in that neighborhood (panel (ii) in Fig. 1.3.1.1). In this case all agents end up investing in human capital, *not* due to their internal economic calculations, but because every agent has at least two skilled-worker *candidates* as neighbors. But suppose instead education is not economically feasible for A and B as in panel (iii), then that information could lead agent C to make the opposite decision. If neighborhood effects are sufficiently strong, agent C could end up in the unskilled sector (panel (iv)) because, from his perspective, that is where the overwhelming majority of his neighbors would work. Agent C would then follow the anticipated career path of peers in order to conform to the social milieu.

Figure 1.3.1.1: Neighborhood Composition and Human Capital Decisions with Maximum Interaction ($\theta = 1$)



(i) (ii) (iii) (iv)

Note: we assume an agent needs at least two skilled worker candidates (TD = 2) in order to invest in human capital

1.3.2. <u>Skilled Worker Wages</u>

How is the unskilled labor wage, w_n, determined? The unskilled worker sector is considerably more tractable because the production function implies a linear relationship between price and the wages, $w_n = p\emptyset$. As output has been chosen as the numeraire with fixed price $P = 1$, the wages for unskilled workers are fully determined. We discuss here the calibration of skilled worker wages, w_s, that are theoretically determined endogenously.[4]

We assume that initially there are L_n unskilled workers and no skilled ones. Thus, the pool of workers, $L = L_n$, and because production begins at time t=1, aggregate output can be determined based on Equation (1.3.1.1). Initial endowments ("bequests" from heaven) are randomly distributed across agents according to a uniform

[4] Galor and Zeira (1993) consider the case of endogenous wages for *unskilled* workers.

probability distribution function. Subsequently, randomly selected agents are offered jobs in the skilled sector but, in order to qualify, they must first acquire the necessary skills. For agents that choose to invest in education, how much would they be compensated? The question is a challenge for numerical analysis because human capital investments and the compensation are both endogenous: wages depend on the supply of skilled workers and vice versa. Fortunately, the following proposition helps resolve the chicken-and-egg aspect of the market for skilled workers.

Proposition 1. The long-run wages for skilled workers converge almost surely to the level that makes an agent to be indifferent between investing and not investing in human capital. It can be shown that this wage satisfies the following lower bound:

Minimum $w_s = (2 + r)w_n + (1 + i)h$ (1.3.2.11)

The proof is by contradiction, but it can also be easily demonstrated by numerical simulations.

By proposition 1, in the long run the compensation for skilled workers is always higher than (more than twice) the unskilled workers wages, w_n. The marginal product of skilled workers (derived from Eq. 1.3.1.2) then determines how many agents, L_s, would be hired at that wage. Production in the skilled sector begins at t=2, at which time the (now "old") agents decide how much to consume and how much to leave for their offspring. The old agents then give birth to the newborns, from which a randomly selected few are offered the skilled worker wages. The young agents who chose to opt out of school are then employed in the unskilled sector, producing output that is again used to pay for sunk costs.

To help intuition, Figure 1.3.2.3 illustrates the connection between wages and aggregate output. When wages in the skilled sector are lower than the minimum W_s (Eq. 1.3.2.11), in equilibrium all workers choose unskilled-sector employment. Conversely, all agents invest in human capital when skilled worker wages are higher than the minimum. Unskilled and skilled workers co-exist only when wages are such that agents are indifferent between the two sectors.

Figure 1.3.2.3: Skilled Worker Wages and Aggregate Output

We perform numerical simulations where skilled worker wages are calibrated according to Proposition 1 in order to prevent the economy from degenerating into a homogeneous equilibrium. The next section details the agent-based algorithm.

1.3.3. Algorithm Implementation

We implement the agent-based algorithm in Java Development Kit 1.6 in conjunction with the RePast library version 3.1 (http://repast.sourceforge.net/repast_3/index.html). Before running scenarios of interests, we set the model parameters at values that would ensure that the simulation produce outcomes where both skilled and unskilled workers coexist. This is a necessary step because, as it turns out, initial explorations suggest that skilled and unskilled workers coexist only in a narrow range of exogenous variables and parameter values. We have already calibrated skilled worker wages based on proposition 1. Table 1.3.3.1 list the values of the additional variables and parameters calibrated in the agent-based simulations.

Table 1.3.3.1: Fixed Parameter Values in the Agent-Based Simulations

Parameters	**Value**
Share parameter in skilled labor production function, β	0.7
Technology parameter, A	30
Wages of unskilled workers	10
Interest rate, r	0.01
Maximum bequest, x	100
Total number of workers, L	100
Consumption parameter, α	0.7
Minimum threshold to invest in education, $\pi_{\min}$	0.5

Having initialized the parameters, the following algorithm is implemented:

1. First, we derive the labor demand schedules for both sectors from the production functions (Eqs. 1.3.1.1 and 1.3.1.2). The demand schedules relate wages to incremental output for both the skilled and unskilled labor sectors. Aggregate supply is the combined output produced in the two sectors.

2. Each agent is then initialized with three binary variables (each taking the value of either one or zero), which represent, respectively, $\boldsymbol{\varphi_i}$, $\boldsymbol{\varphi_{-i}}$, and the tendency to invest in education, $\boldsymbol{\pi_i}$. Agents first determine whether they are prospective skilled workers by comparing the lifetime wealth from an investment in education (Eq. 1.3.1.8 or 1.3.1.9) with that from a career as an unskilled worker (Eq. 1.3.1.7). The binary variable $\boldsymbol{\varphi_i}$ is set = 1 if agent is a prospect, = 0 otherwise.
3. In simulations where we allow neighborhood effects, agents then observe whether nearest neighbors are skilled worker prospects. Since the spatial structure is a square grid lattice, each agent has a maximum of 8 neighbors (the so-called *Moore neighborhood* structure). We consider the case where agents make educational choices depending on the number of neighbors, *TD*, who are expected to invest in education based purely on economic ground (i.e., without taking neighborhood effects into account). Thus, for example, *TD* = 1 means that an agent would invest in human capital if there is at least one prospect for skilled worker in the neighborhood.
4. If the number of prospects $\geq TD$, then φ_{-i} takes the value of 1, otherwise = 0. The tendency to invest in human capital, π_i, can then be calculated for every agent based on Equation (1.3.1.3). Agents for which π_i exceeds the minimum threshold, π_{min}, would actually invest in human capital.
5. The computation of agents' wealth and bequest in the subsequent period follows directly from current period's education choices. In order to avoid negative wealths,

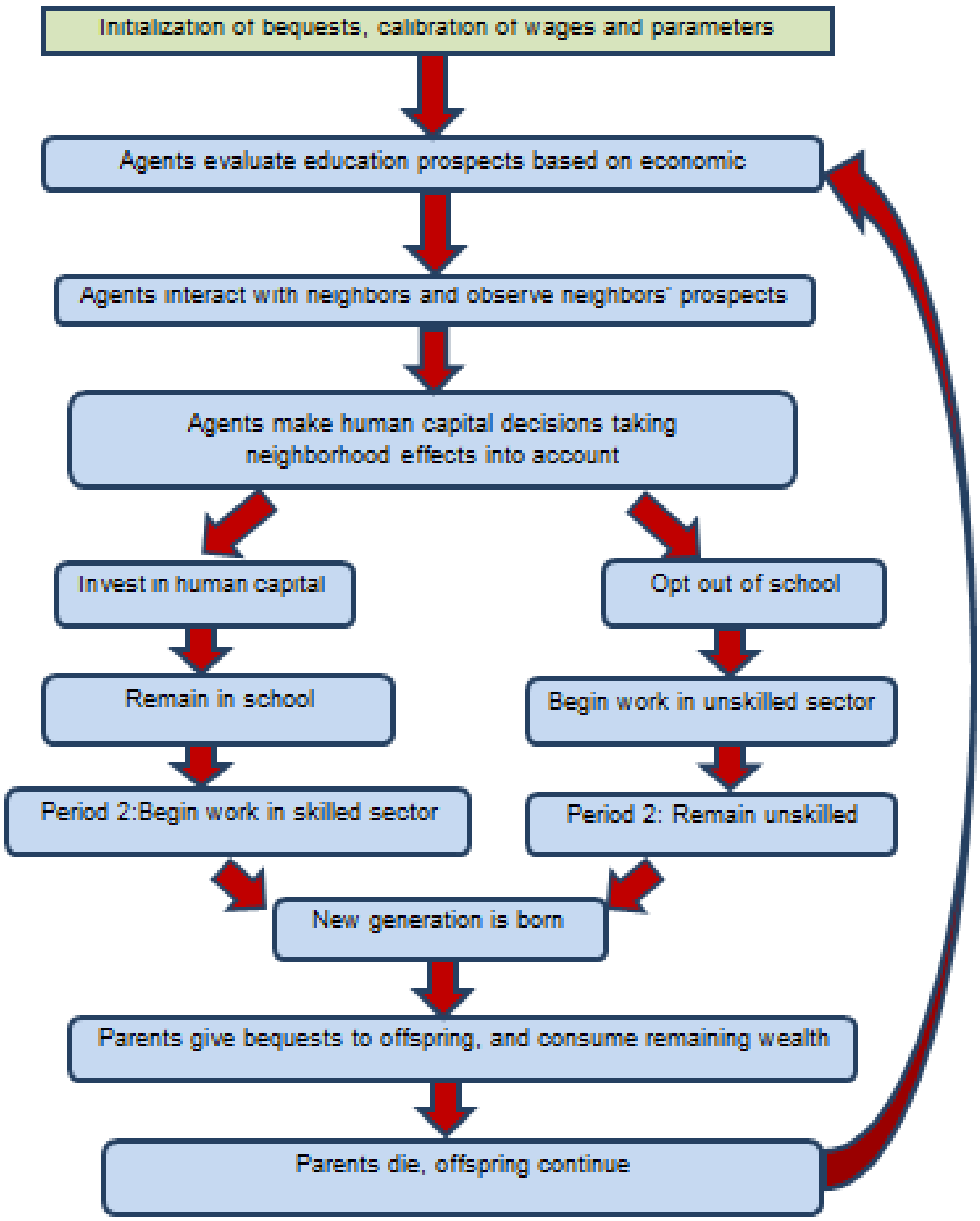
a restriction is imposed on agents' choices so that an investment in human capital occurs only if lifetime wealth is not negative.[5]

6. We consider three different setups:
   a. Setup 1 corresponds to a backward society where initially *no* agent pursued education. Subsequently, higher wages are offered to randomly selected agents, some of which would be motivated to invest in human capital. The wages for prospective skilled workers are calibrated according to Proposition 1.
   b. In Setup 2, the probability for an agent to be offered the higher wage is higher if the parent is a skilled worker. This allows education choices to be correlated across generations.
   c. Setup 3 combines Setups 1 and 2, and in addition all agents offered the higher wages (which they accept) are clustered in one neighborhood. This setup is designed to capture the notion of class segregation (Schelling, 1971). Thus here, unlike in the other setups, the spatial distribution of wealth will strongly affect the future educational status of younger generations.
7. For each setup, we compare the outcomes of simulations with interacting agents with those without interactions under various assumptions regarding interactions strength and the offspring's likelihood to replicate parents' education and economic status (in Setup 2).

The flowchart below (Fig. 1.3.3.1) summarizes the logic of the agent-based algorithm.

[5] This restriction is necessary in order to prevent the economy from spiraling out of control.

Figure 1.3.3.1: The Logic of the Agent-Based Algorithm



1.4. Results

1.4.1. Parameter Observation of Basic Results

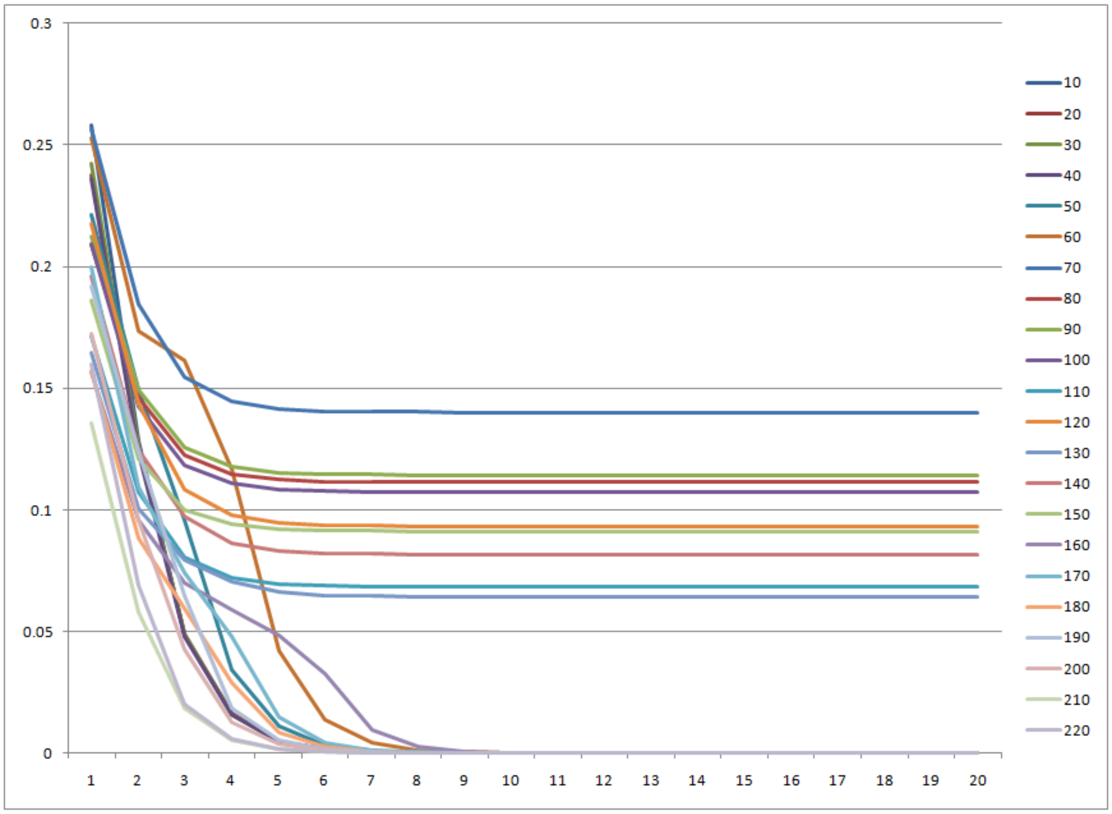
Before we introduce spaces into the basic version of Galor and Zeira's model, we need to observe some of the important parameters that drives its characteristics. In order to establish the positive threshold g, the model requires that either agents have positive wages of skilled labor after education cost $w_s - h(1+i) > 0$ and slope $(1-\alpha)(1+i) < 1$ (Galor & Zeira, p.41), or when the skilled labor wages is - negative after education cost $w_s - h(1+i) < 0$ then the slope $(1-\alpha)(1+i) > 1$ (Galor & Zeira, p.41) which requires that $i < \frac{\alpha}{1-\alpha}$. From Equation (1.2.1.4) we can derive that $\frac{1+\beta r}{\beta-1} < \frac{\alpha}{1-\alpha}$ with $\frac{1}{\alpha-r(1-\alpha)} < \beta$ with $r(1-\alpha) \neq \alpha$. In this study, we chose the value of $\alpha = 0.7$.

To have the value of $f > 0$, since we know that $i > r$, then what we only need the numerator term is to be greater than zero, which we can write as $w_n(2+r) + h(1+i) - w_s > 0$ or simply $w_s < w_n(2+r) + h(1+i)$. Furthermore, to determine that $0 < f < g$, it is necessary that:

$$w_s < \left(w_n(2+r) + h(1+i) + \frac{(1-\alpha)(i-r)h(1+i)}{[1-(1-\alpha)(1+i)]} \right) \bigg/ \left(1 + \frac{(1-\alpha)(i-r)}{[1-(1-\alpha)(1+i)]} \right)$$

Now let's begin with an example where r = 0.01, $\beta = 1.1$, $\alpha = 0.7$ and $h = 20$, $w_n = 10$, *bequest = 100*. We can check that we have: $i = 10.11$, $(1-\alpha)(1+i) = 3.33$, $(1-\alpha)(1+r) = 0.303$, the skilled labor wages that is required to obtain positive g is $w_s < 222.20$, and the skilled labor wages required to obtain positive f is $w_s < 242.30$. Using several values of skilled labor, we checked the related *Gini* coefficients and obtained results displayed in Figure 1.4.1.1. These results confirms that in the area of $w_s \in \{10, 20, 30, ..., 220\}$, we have only the values of Gini that do not converging to zeros in the area of $w_s \in [70, 80, 90, 100, 110, 120, 130, 140, 150]$.

Figure 1.4.1.1: Values of Gini on Different Skilled-Worker Wages



The graph provided by Galor and Zeira for the case when wages are exogenously determined requires that the value of *g > f > 0* and the slope of $(1-\alpha)(1+i) > 1$. Since threshold *g* is positive it requires skilled labor wages to be less than human capital investment $w_s < h(1+i)$, which also guarantees the positive *f* since $w_n(2+r) + h(1+i) > w_s$. There exists a range of values where the condition *g > f* is satisfied. This range can be seen in the following example. Table 1.4.1.1 shows that there exists a range when $f > g$, $f > 0$ and $g > 0$ when $154.9 < w_s < 242.3$ (see panel a) in which the coexistence of low- and high-income groups disappear as shown by panel b when $\frac{w_s}{w_n} > 15.5$ which implies $w_s > 154.9$.

Table 1.4.1.1: Example of Available Range for *g > f > 0*

Parameters	Values
h/wn	2
wn	10
h	20
r	0.01
β	1.1
i = (1+βr)/(β-1)	10.11
(h/wn)(1+i)	22.22
α	0.7
(1-α)(1+i)	3.333
(1-α)(1+r)	0.303
g pos ws <	222.200
f < g needs ws <	154.921
f > 0 needs ws <	242.300
bequst	100.000
(1-α)(i-r)	3.0
1-(1-α)(1+i)	-2.333
(1-α)(i-r)/[1-(1-α)(1+i)]	-1.29876
ws-h(1+r)	29.8
wn(2+r)	20.1
ws > wn(2+r)+(h(1+r))	40.3
h(1+r)	20.2
ws > h/(1-α)	66.7

a. Parameters in the basic model

ws/wn	f	g
1	23.0	27.29
2	22.0	26.00
3	21.0	24.71
4	20.0	23.43
5	19.0	22.14
6	18.0	20.86
7	17.1	19.57
8	16.1	18.29
9	15.1	17.00
10	14.1	15.71
11	13.1	14.43
12	12.1	13.14
13	11.1	11.86
14	10.1	10.57
15	9.1	9.28
16	8.1	8.00
17	7.2	6.71
18	6.2	5.43
19	5.2	4.14
20	4.2	2.85
21	3.2	1.57
22	2.2	0.28

b. Values w_s/w_n on f and g

1.4.2. Scenarios

We consider the following scenarios corresponding to three alternative policy changes, and compare the equilibrium number of skilled workers.

- A reduction in borrowing cost achieved by lowering the loan rates, and this will make education affordable to a greater number of agents.
- A direct reduction in the cost of education for all agents in the economy while leaving the loan rates unchanged.
- A targeted subsidy, focuses on agents who otherwise would not have invested in human capital. For simplicity, we provide the example of a direct subsidy by adjusting the cost of education by a parameter that takes a value between zero and one. This mechanism implies that a transfer payment equals the difference between the subsidized and the full price of education.

In the targeted subsidy simulation, the wealth equation for agents whose bequest values are less than the education cost is modified to include a subsidy parameter, ξ. Thus, in this scenario the wealth of skilled workers who otherwise would have needed to borrow in order to finance their education would be:

$$W_{s,i}(x) = w_s(L_s) + (x_i - (1-\xi)h)\,(1+i) \tag{1.4.2.1}$$

where ξ takes a positive value that is less than one, and ξh is the implicit transfer payment. We use this equation to investigate the impact of different subsidy levels on human capital investments.

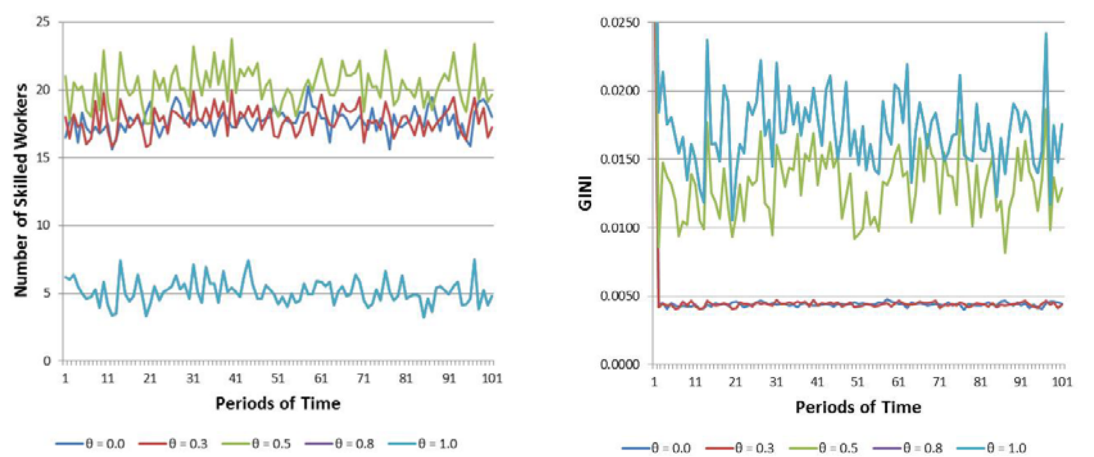
1.4.3. Results of Simulations

For each combination of parameter values and initial setup, we ran Monte Carlo simulations with five different random seeds to control for random fluctuations. Each simulation was run for 1,000 periods. The results reported here correspond to a system populated by 100 agents that live for two periods, in which the borrowing rate, i, is fixed at 0.05. Exactly 100 offspring are born to parents that consume, make bequests, and then die in the second period of life.

We validate the agent-based algorithm (structural validation) by replicating the analytical results of Galor and Zeira (1993), where skilled worker wages are exogenously determined and direct interactions are absent. In particular, our agent-based simulations successfully reproduce the long-run divergence between skilled and unskilled workers from a random-uniform distribution of initial wealth (Galor and Zeira, Fig. 1, p. 41). We note that a model with space but without local interactions produces the same results.

We discuss first the effect of stronger interactions as a result of an increase in the strength of neighbors' influence as captured by the parameter θ (Eq. 1.3.1.3). Note that $\theta = 0$ represents the no-interaction case, where agents make decisions based purely on economic considerations. As it turns out, Setup 2 produces results very similar to those from Setup 3, and not shown here. Figure 1.4.3.1a displays the relationship between interactions and human capital investments (measured by the number of skilled workers) over 1,000 periods in Setup 1. The figure indicates that human capital is consistently highest when agents assign equal weights ($\theta = 0.5$) to neighbors' influence and their pure economic calculations (i.e., without outside influence), and lowest when agents consider only the former ($\theta = 1$). Intermediate levels are observed when neighborhood effects are positive but weak ($0 < \theta < 0.5$), or somewhat strong ($0.5 < \theta < 1$). Thus human capital is highest when agents assign equal weights ($\theta = 0.5$) to neighbors' influence and their pure economic calculations (i.e., without outside influences). At this optimal level, interactions succeed in increasing the likelihood of skilled worker prospects to pursue education and actually realize their potential. Distributions, on the other hand, are most uneven at maximal interactions ($\theta \geq 0.8$ in Fig. 1.4.3.1b), and consistently most equal (lowest Gini) when neighborhood effects are weak or completely absent. Furthermore, it appears that a positive association characterizes the inequality-interaction nexus.

Figure 1.4.3.1: Time Series of (i) the Number of Skilled Workers and (ii) the Distribution of Wealth, Various θ's, Setup 1



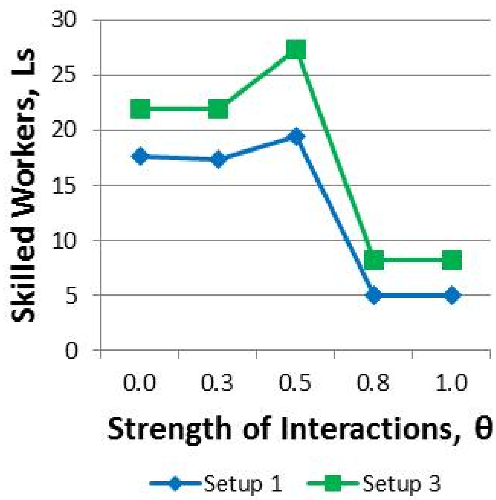
a. Society's level of education, measured by the number of skilled workers over 1000 periods

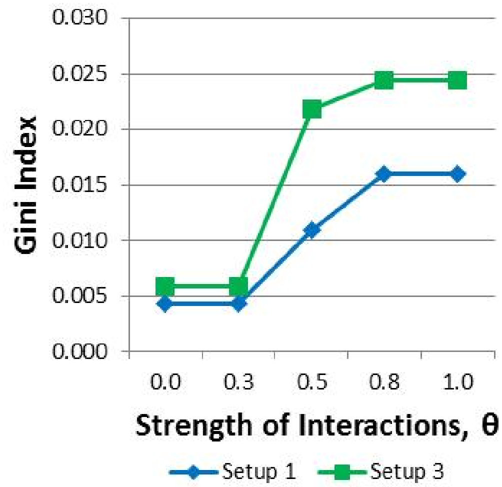
b. Distribution of wealth, measured by Gini index over 1000 periods

Note: 10-period averages are shown in order to reduce noise.

Figure 1.4.3.2 reinforces the findings in a cross section of equilibria at t=1000. As Figure 1.4.3.2a confirms, the steady-state relationship between interaction strength and human capital investments remains non-linear — it is positive — when interactions are weak, but becomes negative as θ exceeds 0.5. The figure also shows that across all levels of interactions, the combination of class segregation and path dependence (Setup 3) yields a higher level of human capital investments. The resulting expansion of output, however, has social repercussions as inequality rises (higher Gini index) and peaking at $\theta = 0.5$ (Fig. 1.4.3.2b). Thus, a tradeoff must be made between higher output and a less equal distribution of wealth when interactions are moderate. Strong interactions ($\theta > 0.5$) lead to lower education and, by extension, a fall in output. At the same time, highly intertwined agents also create a more equal distribution of wealth.

Figure 1.4.3.2: The Relationship between the Strength of Interactions and (a) Society's Level of Education and (b) the Distribution of Wealth, Various Setups, t=1,000





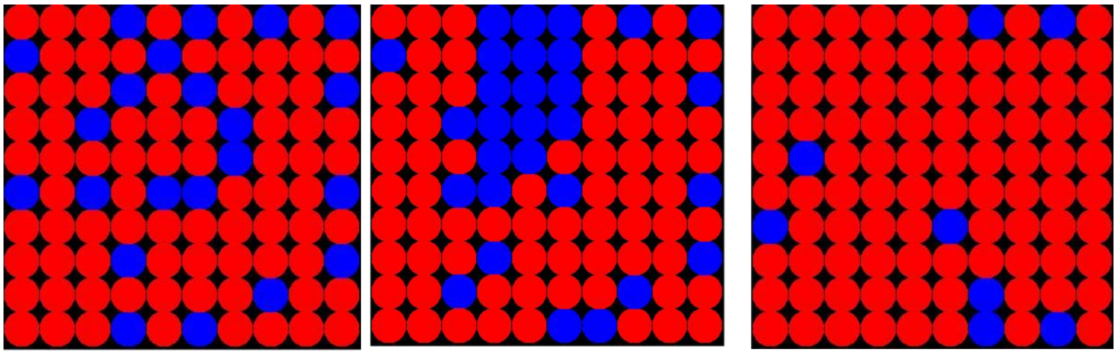
a. Society's level of education, measured by the number of skilled workers

b. Distribution of wealth, measured by Gini index

Note: all simulation runs are with TD = 4.

Figure 1.4.3.3 shows the long-run spatial patterns that emerge from Setup 3 under various interaction levels, θ, with TD fixed at a value of 4. The no-interactions case ($\theta = 0$) leads to about two-tenths of workers being educated. At a moderate level of interactions ($\theta = 0.5$), the proportion of skilled workers is highest, i.e., about one-third of the total. When agents are highly intertwined ($\theta = 0.8$), skilled workers fall precipitously to less than 10% of the entire laborforce. Results from the other setups show very similar pattern.

Figure 1.4.3.3: Spatial Patterns of Neighborhood Seggregation between Skilled (Blue) and Unskilled (Red) Workers, Various Levels of Interactions

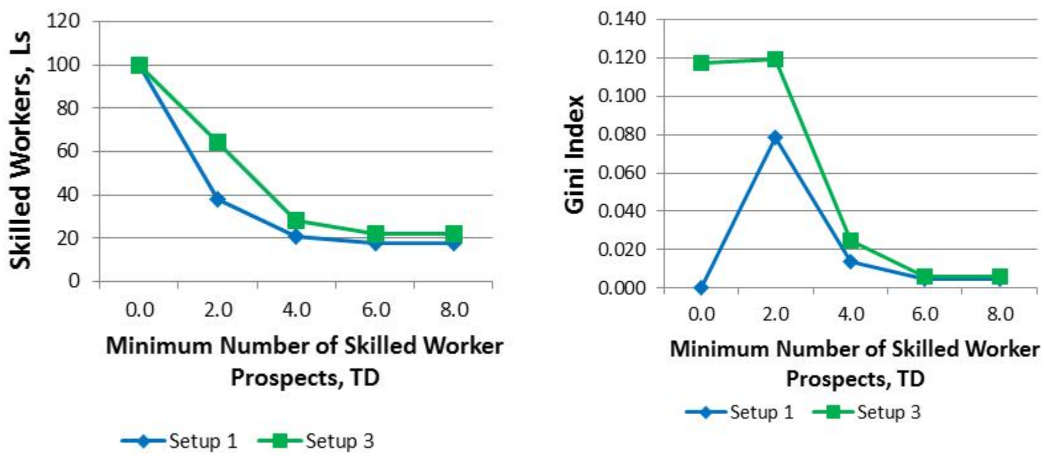


a. Without interactions, $\theta = 0$
b. With interactions, $\theta = 0.5$
c. With interactions, $\theta = 0.8$

Note: simulations are run with *TD* = 4.

Next, we examine an increase in the minimum required number of skilled worker prospects in the neighborhood, *TD*, which led to a decline human capital investments (Fig. 1.4.3.4a) across all setups. This is intuitive. Agents are less likely to pursue education when doing so requires a strong presence of "positive influences" in the neighborhood. Even with stringent requirements, however, segregation and path dependence (Setup 3) continue to yield a steadily high level of education that declines only slightly. The upside of this decline is a concurrent drop in wealth inequality as evident in the lower Gini indexes (Fig. 1.4.3.4b). By contrast, the combination of path dependencies (Setup 2) and a very high requirement for "positive influences" bring about both higher inequality and lower investments in education.

Figure 1.4.3.4: The Relationship between the Minimum Number of Skilled Worker Prospects (*TD*) and (a) Society's Level of Education and (b) the Distribution of Wealth, Various Setups



a. Society's level of education, measured by the number of skilled workers	b. Distribution of wealth, measured by Gini index

Note: simulations are run with $\theta = 0.5$.

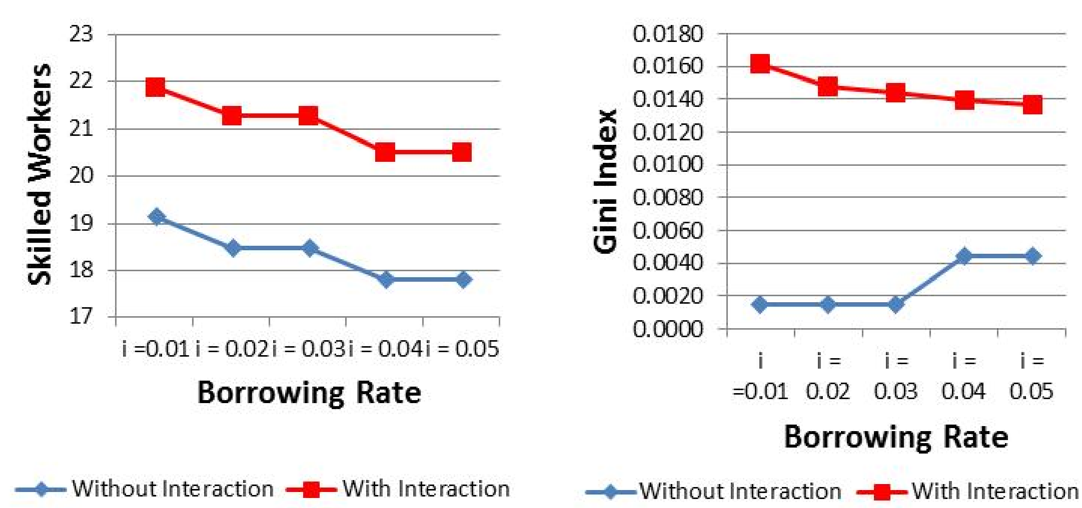
1.4.4. <u>Scenario Analysis</u>

We turn now to the analysis of the three alternative policies mentioned earlier: (A) a reduction in borrowing rates; (B) a reduction in education costs; and (C) targeted subsidies to agents who otherwise would not have invested in human capital. Here the simulations focus on Setup 1, where higher wages are randomly offered and class segregation is absent.[6] Figure 1.4.4.1a shows that lower borrowing rates in Scenario A are associated with a higher level of education, which is bolstered even more by social interactions ($\theta = 0.5$). That is, local influences and lower borrowing rates

[6] It turns out that results are qualitatively very similar under Setups 2 and 3.

complement each other in raising human capital. Figure 1.4.4.1b shows, however, the interaction dependence of the correlations between borrowing rates and inequality. Lower borrowing rates appear to be associated with a decrease in inequality in the no-interactions case ($\theta = 0$). Moderately strong neighborhood effects ($\theta = 0.5$), by contrast, render ambiguous the distributional impact of a decrease in borrowing rates. Starting from a relatively high level (i = 5%), a reduction in the cost of borrowing *exacerbates* initial inequality, but when borrowing costs are already low (i = 2%), a further reduction appears to improve the distribution of wealth. More simulations at finer intervals for both borrowing rates and interactions strength are needed before a more complete picture can be obtained.

Figure 1.4.4.1: Scenario A: Borrowing Rates and (a) Society's Level of Education and (b) the Distribution of Wealth, Various Levels of Interactions



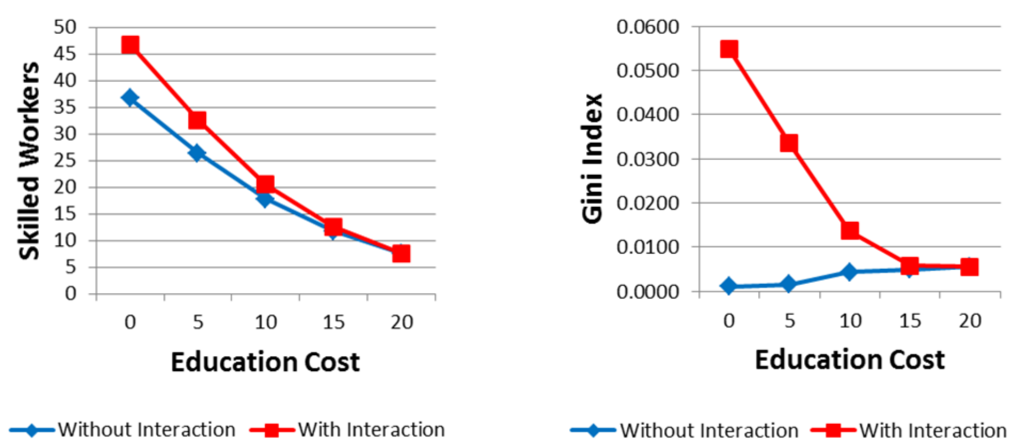
a. $\theta = 0$ and $\theta = 0.5$ for the without and with interaction cases, respectively

b. $\theta = 0$ and $\theta = 0.5$ for the without and with interaction cases, respectively

Note: simulations are run with *TD* = 4.

As expected, in scenario B where education costs are reduced, the level of education when interactions are allowed ($\theta = 0.5$) is significantly higher than when interactions are not allowed ($\theta = 0$).[7] At the same time, the higher number of skilled workers in the interactions case brings about a dramatic increase in inequality. Thus, a reduction in either education costs or borrowing rates (Senario A) brings about results that are very similar in terms of aggregate output and inequality, as can be seen in Figure 1.4.4.2.

Figure 1.4.4.2: Scenario B: Education Costs and (a) Society's Level of Skilled Workers and (b) the Distribution of Wealth, Various Levels of Interactions



a. $\theta = 0$ and $\theta = 0.5$ for the without and with interaction cases, respectively

b. $\theta = 0$ and $\theta = 0.5$ for the without and with interaction cases, respectively

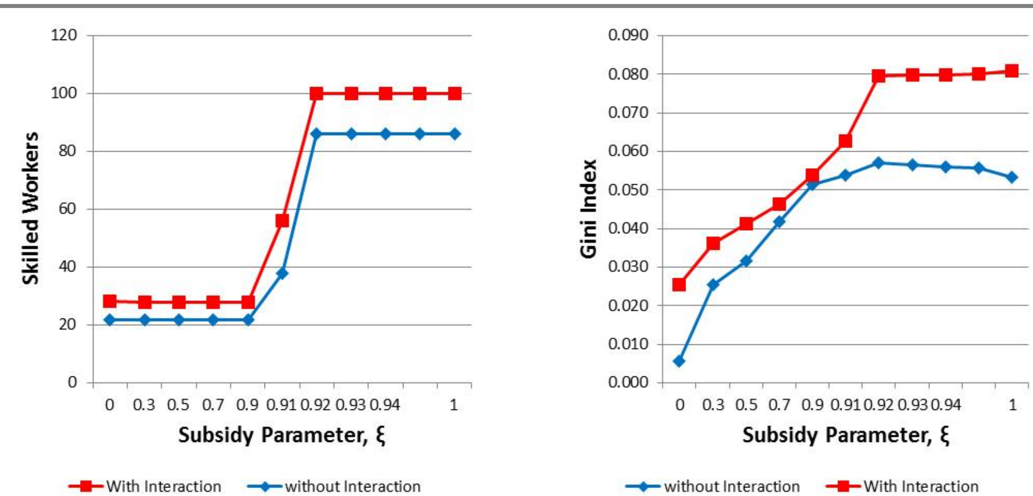
Note: simulations are run with *TD* = 4.

Next, we examine scenario C, where we use subsidies to target agents who otherwise would have borrowed to finance their education. Figure 1.4.4.3a shows that human capital investments begin to respond only when education is close to being

[7] Results not reported here due to space considerations.

fully subsidized. The increase, however, is dramatic (more than double) when the subsidy is at least 90% of costs, which suggests a *phase transition* in education. When the subsidy is not high enough, education is impervious to transfer payments. Once the 90% breakpoint is surpassed, education becomes very responsive to additional subsidies. All the investigated cases exhibit phase transitions, yet, as in the other scenarios, the increase in human capital worsens the distribution of income. Notice, however, that inequality increases even *before* education starts its upward trajectory (Fig. 1.4.4.3b). As it turns out, subsidies increase the lifetime wealth of those that are fortunate to be the recipients, and this brings about higher inequality despite the stable overall level of education.

Figure 1.4.4.3: Scenario C: Targeted Subsidies and (a) Society's Level of Education and (b) the Distribution of Wealth, Setup 1



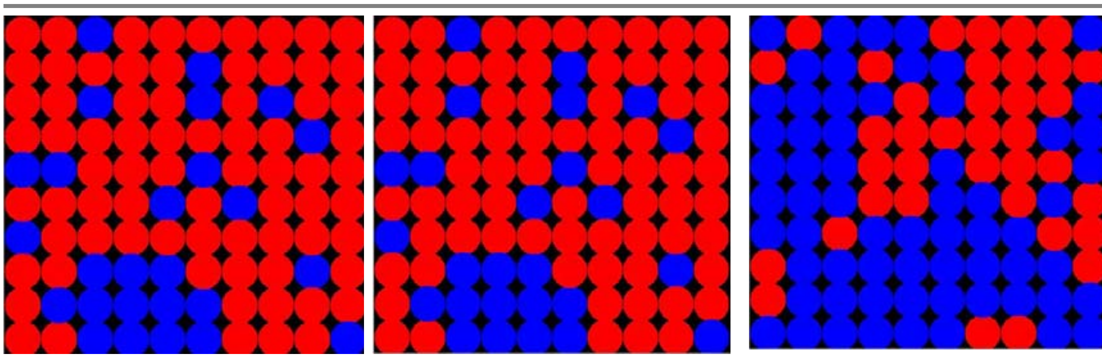
a. $\theta = 0$ and $\theta = 0.5$ for the without and with interaction cases, respectively

b. $\theta = 0$ and $\theta = 0.5$ for the without and with interaction cases, respectively

Note: simulations are run with $TD = 4$.

The results for Setup 3 are qualitatively very similar to those under Setup 1. Thus, regardless of whether wealth is correlated over generations or across locations, we found out human capital responds only to very high subsidy levels. When it does respond, however, the results are dramatic in terms of both output (because there are many more skilled workers) and inequality. Figure 1.4.4.4 shows the long-run spatial patterns that emerge under different levels of subsidies. Absent to moderate subsidies ($\xi = 0$ and 0.5) result in not only the same level of human capital (with one-fourth of workers being educated) but also virtually identical patterns of class segregation (Fig. 1.4.4.4a and 1.4.4.4b). When subsidies are very high covering at least 90% of education costs ($\xi = 0.91$), the share of skilled workers jumps to over half of the laborforce (Fig. 1.4.4.4c). Moreover, educated workers tend to cluster together within the same neighborhood.

Figure 1.4.4.4: Spatial Patterns of Neighborhood Seggregation between Skilled (Blue) and Unskilled (Red) Workers, Various Levels of Subsidies



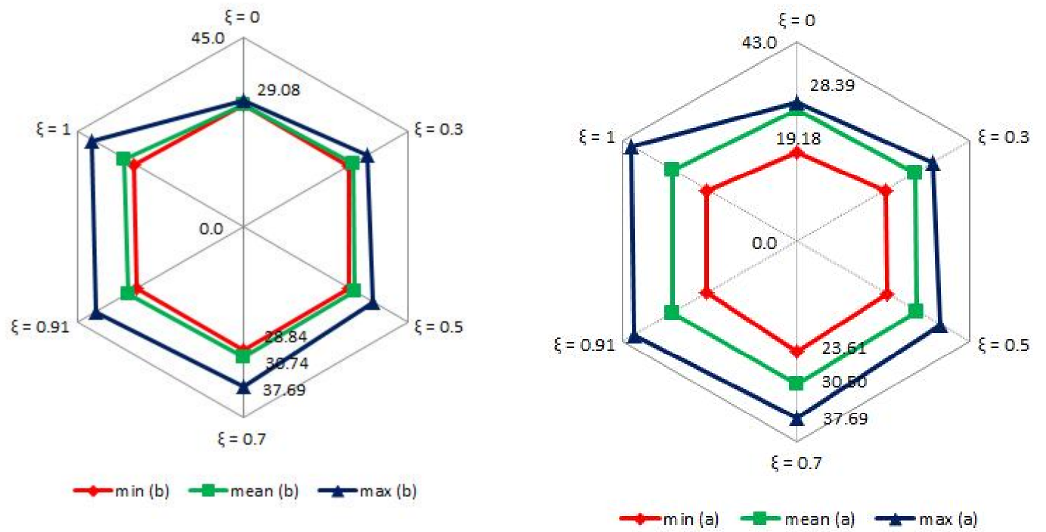
a. $\xi = 0$ b. $\xi = 0.50$ c. $\xi = 0.91$

Note: simulation runs with Setup 1, interaction level $\theta = 0.5$, and $TD = 4$.

How does inequality rise when more workers become educated, despite the constant population? This seems to be counter-intuitive, at least at first glance. Figure 1.4.4.5 shows the widening wealth gap between skilled and unskilled workers as subsidies are increased. Under the no-interactions case (panel a), the original scenario ($\xi = 0$) leads to a mean wealth (=29.08) that roughly coincides with the minimum and maximum values. A subsidy that effectively reduces education costs by 70% ($\xi = 0.7$), on the other hand, results in a 26% increase of maximum wealth while keeping the minimum at about the same level, thereby creating a chasm between skilled and unskilled workers. The size of the skilled workers group, however, remain the same (about two-tenths of the total laborforce) as in the original scenario. When subsidy is further increased to cover 90% of costs, the amount of skilled workers suddenly jumps to over 85% of the total (see fig. 1.4.4.3). At the same time, the dramatic expansion in output pushes inequality higher by virtue of the increasing isolation of the low-wage, unskilled workers.

Allowing direct interactions ($\theta = 0.5$) brings about a larger gap at every non-zero level of subsidies (panel b). It appears that the combination of neighbors' influences and high subsidies not only raises the top wealth as in the absence of interactions, but also *lowers* the wealth of those already at the bottom of the distribution.

Figure 1.4.4.5: Scenario A: Targeted Subsidies and the Distribution of Wealth, Setup 1



a. No direct interactions, $\theta = 0$ b. With interactions, $\theta = 0.5$

Note: simulation runs with Setup 1, interaction level $\theta = 0.5$, and *TD* = 4.

1.5. Discussion and Conclusion

Several insights can be drawn from this agent-based model of wealth inequality in a spatial economy which is characterized by local interactions and initial heterogeneity. We found that human capital investments (and therefore output) are maximal when local interactions are moderate (i.e., $\theta = 0.5$), neither too weak nor too strong. Thus, equal consideration of one's own-economic calculations and information about one's neighbors' prospects produces the highest level of education, and therefore output. Stronger interactions ($\theta > 0.5$) lead to prospects in the poor (low-wealth) neighborhood to opt out of school (though non-prospects in the wealthy neighborhood remain in education), and this reduces overall human capital. On the other hand, weaker interactions ($\theta < 0.5$) lead to non-prospects in wealthy neighborhood to opt out of school (though skilled worker prospects in the poor neighborhood remain in education), and this also reduces overall human capital.

The distributional impact of interactions exhibits a similar pattern, but of course with very different ramifications assuming that society values an egalitarian distribution of wealth. Specifically, the level of interactions ($\theta = 0.5$) that maximizes output also generates the most unequal distribution. Thus, the agent-based simulations suggest diametrically-opposite directions for output and equity should the extent of local interactions change either way. An exogenous shock leading to a more cohesive community (associated with $\theta > 0.5$) for example, lowers output but at the same time produces a more equitable distribution. The upper tail of Figure 1.4.4.5 suggests, however, that very strong interactions beget a severe contraction in output, but only a moderate reduction in inequality. By contrast, very weak interactions precipitate a mild contraction and, at the same time, significantly lower inequality. It appears that when agents are strongly interacting, the influence that causes prospects in poor neighborhood to adapt (by opting out-of-school) overwhelms the influence that persuades non-prospects in wealthy neighborhood to adapt (by staying in school). Thus, very strong interactions produce "too much" adaptation among would-be prospects but not enough among non-prospects, which in turn is associated with a severe contraction of output coupled by relatively high inequality.

The adaptation of agents through interactions might be motivated by the influence of "others" who are perceived to be socially superior (Mugny and Perez, 1991).

Agents in our model become susceptible to conversion (e.g., an initial non-prospect becomes educated, or vice versa) if a critical mass of "others" is present nearby. Adaptation occurs if, in addition, agents are allowed to locally interact ($\theta > 0$) and the resistance to local influence (π_{min}) is not too high. Under a favorable set of conditions, the presence of prosperous neighbors converts a non-prospect into a skilled worker due to the perceived advantages associated with being educated, and vice versa. As Turner (1983) argues, the descendants of poor families likely identify themselves as being socially inferior and economically disadvantaged. It is precisely this social identity that motivates them to follow the anticipated education path of their well-to-do peers if there is a *critical number* of the latter in the neighborhood.

Kirman (1993) has argued the importance of critical points in explaining the switch from one choice to another. In our context here, skilled-work prospects "recruit" other agents in the neighborhood, even those for whom education would be the second best choice. History matters because of positive feedbacks in the sense that the size of the educated neighborhood determines the probability for non-prospects to convert. Conversion occurs if the number of educated neighbors reaches a critical level, and this makes offspring even more likely to be educated in subsequent periods. Thus in a different context, when confronted with choices that are comparable in every aspect, social interactions might nevertheless compel people to consistently choose one over the other (Becker, 1991).

The agent-based simulations reported in Section (1.4.4) suggest that the economic impact of education policies depends on the history of the policy itself and the extent of social interaction. A prime example is targeted subsidies that produce results in terms of higher human capital investments and output, but only when a large subsidy is already in place. Furthermore, the impact magnitude also depends on the strengths of local interactions. But in order to explore which policy is most effective in promoting education, the simulations must be setup such that the efficacy of different policy instruments can be compared.

Comparability can be accomplished by assuming a fixed government budget, which in any run can only be used to fund a single policy implementation. This enables us to compare the policy of reducing education costs with the policy of targeted subsidy, as long as the total expenditures for both are *ex-ante* identical.[8] Preliminary results suggest that human capital investments under targeted subsidies almost double the level under a comparable scheme to slash education costs. That is, subsidies targeted toward those who would otherwise be unable to pay for education appear most effective in terms of motivating people to pursue education. In terms of per dollar of public expenditures, cost reduction results in higher human capital investments *and* lower inequality than subsidies. Thus, reducing education costs across the board appears to be effective not only in motivating people to pursue education but also in creating a more egalitarian distribution of wealth.

Decision makers can make policy even more effective if they know the extent of local interactions because they can then determine the amount of subsidies required to achieve a given level of education. While efficiency (i.e., a smaller budget) and effectiveness (i.e., more skilled workers) generate higher output in the aggregate, it

[8] The total expenditures would be *ex-post* identical only in the trivial case where every agent invests in human capital because education has been artificially made affordable to *all* agents.

also brings about possible setbacks associated with the negative consequences of wealth disparities. Our preliminary analysis indicates that targeted subsidies lead to a significantly more unequal distribution of wealth as measured by the Gini coefficient. Due to the efficiency-equity tradeoffs, the decision-makers' preference for different mixes of output and inequality becomes very important. While our model does not examine the social consequences of higher inequality, it does suggest that a focus on human capital investments that neglects this negative side effect would severely overestimate the impact on the broader society.

One final point that our model makes is the role of spatial interactions in the presence of heterogeneity. The wealth gap between the poor and the rich is becoming increasingly more pronounced in today's economy, and our model suggests that interactions play an important role in influencing one's decision to invest in education. One could imagine a more complex system where there is also heterogeneity across agents in terms of the minimum number of skilled worker prospects required in order to invest in education. In addition, geography plays a role as those who are in the proximity of skilled neighbors are more likely to pursue education than they would have been otherwise. Relating to economic growth, when more people are educated, more output will be produced. Therefore, when two areas have different population characteristics in term of social interaction and segregation (upon education attainment) then the economic growth of those two areas will differ. In a bigger spectrum, this may explain at least partially why the same policies toward education in one area might create different outcomes in term of the number of skilled workers and its economic growth. The social interaction and segregation of agents might be one of the social aspects that need to be investigated more in addition to the possible frameworks of research in economic development.

Future research might also consider the possibility of examining the case where educated agents who work as skilled workers and have significantly higher income are actively promoting education to those who are uneducated. We could also add the migration of low-income groups into a higher-income groups' society, attracted by such one-way promotion from the skilled workers, thus setting the high income earners to one specific location in the lattice and letting the low earners be somewhere outside. This and other policy implications need to be investigated further in future studies.

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APPENDIX 1A

PROOF OF PROPOSITION 1 BY CONTRADICTION

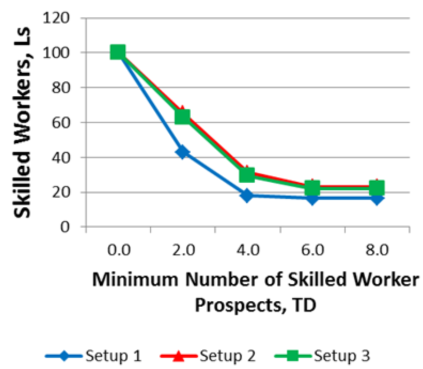
Since we know that the wealth of the non-skilled labor is $M_n = (1+r)(x+w_n) + w_n$ and the wealth of skilled labor is either $M_s = w_s + (x-h)(1+r)$ or $M_s = w_s + (x-h)(1+i)$, then it follows that every agent will be indifferent when $w_s = (2+r)w_n + (1+i)h$. Suppose that $w_s > (2+r)w_n + (1+i)h$, then there is an incentive for any unskilled workers to pursue education and work at level $w_s' = w_s - \epsilon > (2+r)w_n + (1+i)h$ with $\epsilon > 0$ thus increasing the number of skilled workers and pulling down the level of skilled wages further. Now if $w_s < (2+r)w_n + (1+i)h$, then no more unskilled workers are attracted to pursue education and work as a skilled worker as they would be better off by being unskilled workers. Therefore, by contradiction, $w_s = (2+r)w_n + (1+i)h$. ■

APPENDIX 1B

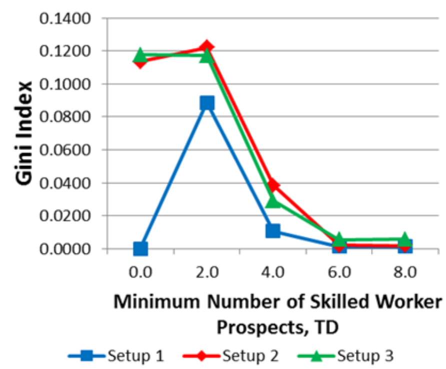
RESULTS OF CHANGING TD AND STRENGTH OF INTERACTION

(SETUP 1, 2, AND 3)

The result of changing TD toward number of skilled workers (panel a) and Gini Index (panel b) under three Setup 1, Setup 2 and Setup 3:

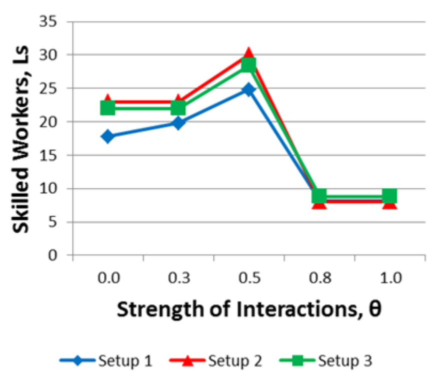


a. Skilled workers effects

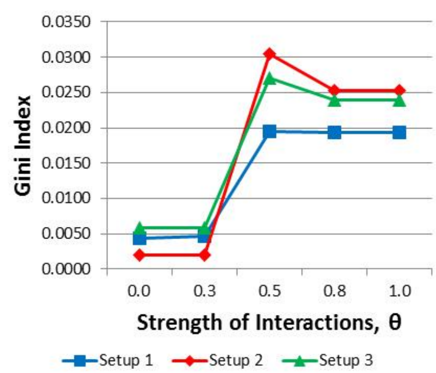


b. Gini Index effects

The result of changing strength of interaction, θ toward number of skilled workers (panel a) and Gini Index (panel b) under three Setup 1, Setup 2 and Setup 3:



a. Skilled workers effects



b. Gini Index effects

APPENDIX 1C

PROSES OF MAKING A CHOICE BY AN AGENT (*TD* = *4*):

The Proses of Making A Choice by An Agent Under *TD* = *4*:

1	0	1
0	X	1
0	0	0

Agent X observes 3 neighbors (identified by number "1") choose education and 5 not, so agent X determines that the neighbors choose not to invest in education.

1	0	1
0	X	1
0	1	0

Agent X observes 4 neighbors choose education (identified by number "1") and 4 not, so agent X determines that the neighbors invest / not invest in education with 50:50 chance.

1	0	1
1	X	1
0	1	0

Agent X observes 5 neighbors choose education (identified by number “1”) and 3 not, so agent X determines that the neighbors choose to invest in education.

CHAPTER 2

TIME INCLUSION IN STRUCTURAL PATH ANALYSIS WITH A CASE STUDY OF THE 2008 INDONESIAN SOCIAL ACCOUNTING MATRIX

2.1. Introduction

This paper seeks to estimate the use of time in Structural Path Analysis (SPA). In SPA the relationships between sectors in Social Accounting Framework (SAM) can be decomposed into three important influences: direct, total and global influence (Defourny and Thorbecke, 1984). Direct influence represents the size of influence from the origin sector to the destination caused by changes of its inputs through a specific path without considering the loops. The total effect itself represents the total of all direct and indirect influences (through various loops) between the origin and destination sectors. The global influence is simply the output SAM multipliers or in a more precise term as marginal expenditure multipliers. The influence can be thought as a subsequent influences arriving to a destination sector at various time starting with its direct influence. As noted by Defourny and Thorbecke in their paper's footnote (1984, p.131):

> "… The various influences and effects occasioned by an exogenous injection are assumed to be instantaneous (including the multipliers). In reality, however, the transmission of economic influence from one pole to others takes time. In particular, it is reasonable to assume that the time required for the transmission of the influence along of a given elementary path would vary in function of the number and length of adjacent circuits. It is also reasonable to assume that the larger the number of poles contained in an elementary path or an adjacent circuit, the longer it will take for the influence to be transmitted from the pole of origin to the pole of destination. Consequently, the existence of relatively long and powerful circuits and correspondingly high path

> multipliers would seem to imply that the transmission of influence would tend to be slower than in the converse case of low path multipliers and a high ratio of direct to total influence."

The time required for the transmission of those influences determines the proxy of the length of time needed for an economic shock to travel from its origin to its destination. The transmission of an economic influence depends on the production and distribution process time and may impose some time value related to the processes.

SAM which was pioneered by Richard Stone is a square matrix depicting a 'snapshot' of the economic structure of a region. The matrix contains several economic accounts. Each of which consists of one row and one column. The row of each account represents income from other accounts while the column represents the expenditure. The total income must be equal to the total expenditure which is represented by the equal sum of the total columns and the total rows. Inherently, SAM can capture the structure of interactions between factors of production, institutions and production sectors.

Thorbecke (1998) discuss how SAM with its regional and interregional framework can contribute significantly to the analysis of social welfare of different economic groups related to particular government policies or programs. One of its uses is to track how the transmission of the economic influences resulted from one economic shock. The overall economic influence from one sector to another is represented specifically by the SAM multiplier of those specific sectors. SAM multipliers are essentially the cells in the inverse matrix that result from the subtraction of the SAM coefficient matrix from the identity matrix after putting aside some exogenous accounts. Unlike the input-output (IO) model which has explicit exogenous accounts, in SAM, there is at least one account that is treated as an exogenous account to make the SAM matrix invertible and thus can be treated as in the IO model.

Pyatt and Round (1979) break the multipliers of SAM into three categories in three multiplicative terms which can then be rearranged into four additive components (Stone, 1985), namely the initial injection, the net contribution of the transfer multiplier effects, the net contribution of open-loop or cross multiplier effects and the net contribution of circular closed-loop effects. In term of regional SAM, these can be referred to as net intra-regional effect, net spillover effect and net inter-regional feedback. One of the applications of this decomposition is figuring multipliers of regional and world trade in Malaysia (Round, 1985).

Though this decomposition can help policy makers to analyze the structure of one economic system, it cannot be used to examine the possible bottlenecks that could exist in the system. Furthermore, the previous decomposition cannot sufficiently explain the SAM multipliers in term of tractable influence transmission from the origin to the destination sector. These last two goals were accomplished by Defourny and Thorbecke (1984)'s SPA which decomposes the SAM multipliers (which is also called as the Global multipliers) into total influences consisting of direct and indirect influences. Direct influence is simply the influence that travels directly from the origin to the destination without going through any loops; total influence, on the other hand, is the amount of influence (including indirect effects) that is transmitted through all possible structures in the path connecting the origin to the destination pole. We are going to discuss in a more detail way about this method in the methodology section.

Many papers have been published exploring the usage of SPA in various countries to explain the mechanism by which a shock is transmitted to specific sectors of interest. Of the many examples that are related to Indonesia's economic development, a few make use of SPA: Azis (2006, 2009) tracked the influence of oil price increase and oil subsidies in Indonesia; Azis (2000) analyze transition from financial crisis to social crisis, Sonis et al. (1997) explored the structure of the interregional economies in Indonesia, Thorbecke and Jung (1996) analyzed poverty alleviation in Indonesia, and Khan and Thorbecke (1989) analyzed technological choices in the agricultural sector in Indonesia.

Employing the SPA method, we can locate bottlenecks that may arise in our system when one shock is transmitted via several other sectors before reaching its final destination sector. In practice, the bottlenecks are determined in context of the analysis and influenced by our understanding of the mechanism through which one specific shock should be transmitted. By employing SPA, one can estimate the total effect and its related path multiplier which reinforces the initial injection and determine paths where the multipliers are considerably small and possible obstructions in its paths. Though this is quite informative, people often ask how long the initial shock will take to reach its final destination. If we could somehow estimate the time required to transmit the shock, then we could come up with the probable timeframe within which a shock would reach a given sector.

In this paper, we will introduce how actually time can be computed and apply that as an exercise to analyze the transmission of influences from two sectors namely agricultural-crop sector and chemical and metallic sector to various household groups in Indonesia based on the 2008 Indonesian SAM. Of course during all the computation, we apply the main SAM assumptions such as a fixed-price multiplier and demand driven model, no substitution possibilities, the same structure of production across sectors as a result of employing some aggregation across different economic sectors. The papers will be divided into five sections. The first and second sections cover the introduction and the literature review. The third section will discuss the methodology of SPA and how the inclusion of time can be done and the fourth section explains the results of our exercises. The last section provides the summary and discussion of this chapter.

2.2. Literature Review

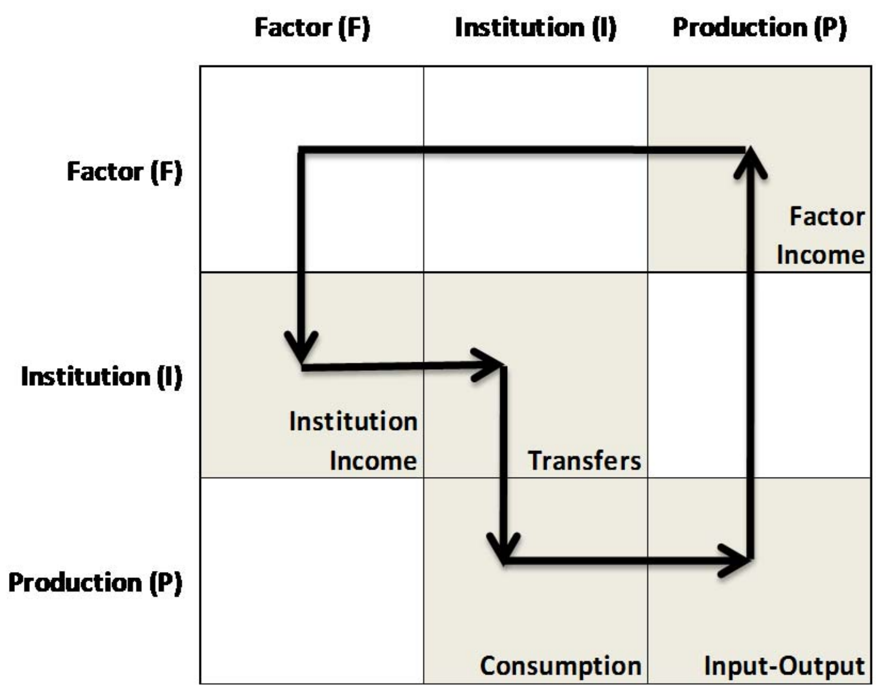
SAM is a data system which inter-linkages factors of production, institutions and production sectors into one square matrix where the sum of the rows (receipts) equals the sum of the columns (expenditures). It adopts the single-entry system instead of the double-entry system that is common in accountings. The double-entry system is also known as the T-account where each transaction is recorded twice in asset as well as credit. By using the single-entry system, each transaction is only recorded once, either as income or expenditure. The equality of the row total to the column total ensures that every receipt must be spent entirely in the form of consumption (domestic commodities or import commodities) and savings (investment).

Compared to IO model, SAM is more useful in modeling especially related to the analysis on income distribution and welfare of different income groups. While it is always possible to derive the IO from the SAM, the opposite conversion derivation from the IO to the SAM is really difficult (Pyatt, 1999). Pyatt and Thorbecke (1976) show how SAM as a consistent and complete data system can capture the interdependence between production activities, institutions and factors and can be used as a solid framework for policy analysis. From the standpoint of economic modeling, a model that is built upon a SAM matrix can guarantee against the possibility of no solution to the model since at least it has a solution in its base period (Pyatt, 1988). Whereas many other models have focused on economic welfare, industrial structures and economic resources, the SAM focuses more on income distribution and social welfare issues related to different economic groups within an economy.

The relationship between factors (F), institutions (I) and production (P) can be summarized as in Figure 2.2.1. Of all the cells in the SAM matrix, only the gray cells have non-zero values, and these cells reflect the circular flows of economic activities. Inter-linkages between production sectors are captured in the sub-matrix P-P in the lower-right corner of the SAM matrix, which is essentially an IO matrix. This P-P sub-matrix describes the inputs of each sector and its output to other sectors, including the value-added to the factors of production. These values-added to the factors of production are called ‘factor incomes’ and are represented by the sub-matrix F-P in the upper-right corner of the SAM matrix. These factor incomes are owned by households under the institution and are represented by the sub-matrix I-F in the mid-left of the SAM matrix. There are transfers between the households such as that between parents to children and between neighbors, and also between enterprises and households as well as between government and households. These transfers are captured in the sub-matrix I-I in the center of the SAM matrix. Later on, these incomes are spent on goods and services, whether domestic or imports. These activities are captured in the sub-matrix P-I in the lower-center portion of the SAM matrix.

Consumption by institutions creates demand for goods and services produced by the production sectors. This increase in demand is then transformed into an increase in the goods and services produced by the production sectors. Thus, such circular flows of the economic activities are represented clearly by the SAM matrix.

Figure 2.2.1: SAM Matrix Structure



This study uses the 2008 Indonesian SAM, which is comprised of 102 by 102 cells. Since 1975, SAM statistics have been issued every five years by the Indonesian Statistical Body (Badan Pusat Statistik - BPS). Though, in the event of drastic changes in the economic structure due to a crisis or political instability, SAM can be published more frequently (i.e., SAM 1998 and SAM 2008). In this case, the 2008 SAM was produced as an estimation by Bank Indonesia and BPS before the official release of SAM 2010, which will be within the 2013/2014 period. Therefore, there are currently about 9 SAM matrices: 1975, 1980, 1985, 1990, 1995, 1998, 2000, 2005 and 2008. Among all other SAMs, the 1998 SAM contains much less cells than the other SAMs and serves mainly as preliminary figures of the structural changes of the economy after the 1997 Indonesian financial crisis.

The 2008 Indonesian SAM is a 105x105 cell matrix, consisting of 17 factors of production (16 labor factors and 1 non-labor factor), 8 household groups (including two groups of non-labor force and one unclear worker classification), 1 enterprise and 1 government, 24 sectors of production, 48 commodities (24 domestic commodities and 24 import commodities), 2 trade and transport margins, 2 indirect taxes and subsidies, 1 capital account and 1 external account. Due to some zero rows and columns under the import commodities, there are only 102 non-zero rows (columns). A small version of the 2008 Indonesian SAM (13x13 cells) can be seen in Table 2.2.1.

Based on the 2008 Indonesian SAM, the distribution of income between different households can be seen in Table 2.2.2. It is clear that the government transfer plays an important role in contributing to the farm workers' income. As a comparison, the government transfer comprises almost one-fourth of the total farm workers' income, whereas it comprises less than five percent of the total high entrepreneurs' income. On the other side, the capital income of the high entrepreneur rural group is the largest, while that of the farm workers, as expected, is the lowest.

Table 2.2.1: 2008 Indonesian SAM (13 x 13 Matrix)

Expenditure → / Receipts ↓			I. Factors of Production		II. Institution			III.	IV.	V. Commodities		VI.	VII. Indirect Taxes & Subsidies		VIII.	Total
			Labor	Non Labor	Households	Enterprises	Government	Production Sectors	Trade and transport margins	Domestic	Import	Capital Account	Indirect Taxes	Subsidies	External Account	
			1	2	3	4	5	6	7	8	9	10	11	12	13	
I. Factors of Production	Labor	1						2,692,618							1,707	2,694,325
	Non Labor	2						2,464,317							6,658	2,470,975
II. Institution	Households	3	2,688,905	788,550	43,365	43,085	199,034								63,506	3,826,445
	Enterprises	4		1,591,198	35,164	176,470	89,692								24,177	1,916,702
	Government	5			85,073	650,053	181,676						344,940		2,291	1,264,033
III. Production sectors		6								10,175,382	0			199,702		10,375,084
IV. Trade & Transport Margins		7								1,000,473	170,506					1,170,980
V. Commodities	Domestic	8			2,973,367		277,090	4,190,140	1,170,980			1,314,139			1,487,238	11,412,954
	Import	9			344,737		17,477	1,028,009				194,691		41,189		1,626,103
VI. Capital Account		10			325,444	990,597	229,473									1,545,515
VII. Indirect Taxes and Subsidies	Indirect Taxes	11								237,099	107,841					344,940
	Subsidies	12					240,891									240,891
VIII. External Account		13	5,420	91,227	19,293	56,497	28,700				1,347,756	36,684				1,585,576
Total			2,694,325	2,470,975	3,826,445	1,916,702	1,264,033	10,375,084	1,170,980	11,412,954	1,626,103	1,545,515	344,940	240,891	1,585,576	

Source: BPS

Table 2.2.2: Households' Income and Government's Transfer to Households

Household Groups	% of Income Receipt			Total	% of Institution Income
	Factor Income		Transfer		
	Capital	Labor	Government		
Farm workers	6.4%	59.6%	24.0%	173,145	3.3%
Farm enterpreneurs	18.1%	70.9%	7.1%	1,246,993	23.5%
Low Enterpreneurs rural	18.5%	67.5%	8.6%	1,162,701	21.9%
Not a labor force and unclear workers classification rural	21.3%	64.5%	8.1%	206,047	3.9%
High Enterpreneurs rural	30.2%	66.7%	0.7%	1,219,989	23.0%
Low Enterpreneurs urban	18.4%	72.9%	4.2%	965,459	18.2%
Not a labor force and unclear workers classification urban	21.6%	70.0%	4.7%	285,032	5.4%
High Enterpreneurs urban	23.2%	74.7%	0.4%	39,603	0.7%

Source: Author's Process on Indonesian SAM 2008

2.3. Methodology

SAM as a balanced matrix system has enormous advantages for analyzing the economic structure of one country. As discussed in depth by Pyatt (1999) how SAM can be used to explain the interdependence links between income distribution and production structures and hold key features of balance T-Account identity[1] which is very important to the social accounting framework. Pyatt and Round (1979), Defourny and Thorbecke (1984), and Round (1985) contributed significantly to decomposing SAM multipliers in an effort to explain and track the transmission of the economic influences caused by an exogenous shock. Defourny and Thorbecke decomposed SAM multipliers into their elementary paths and related the multipliers with the SAM marginal expenditure propensities.

[1] The T-Account represents every transaction in a double entry system: one in asset (debet) and the other in liabilities (credit).

We employ Khan and Thorbecke (1988)' suggestion of using the marginal expenditure instead of just the average expenditure since any additional expenditure might not follow the simple ratio of consumption and income. The average expenditure propensity (*AEP*) is the ratio of the expenditure from the consumption block divided by the total expenditure, $AEP = C/Y$ with C as the consumption and Y as the total expenditure. The expenditure approach assumes that any additional expenditure would be spent in the same proportion as the ratio of consumption to total expenditure. On the other hand, the marginal expenditure is defined as the ratio of any additional consumption to the total expenditure, $MEP = \Delta C/\Delta Y$ with ΔC is the additional consumption and ΔY is the additional total expenditure. The relationship of marginal expenditure and the average expenditure is through the elasticity of consumption, $\varepsilon = (\Delta C/C)/(\Delta Y/Y)$ such that the marginal expenditure is the product of the elasticity of consumption with the average expenditure $MEP = \varepsilon.AEP$. We use the data of the elasticity of consumption from Khan and Thorbecke (1988 p.194-195).

As a common practice, generally people just assume that all influences will be transmitted within some period of time without elaborating it in more specific details. With regards to this, when we are seeking to estimate the range of time required to transmit almost all of the influence, we must examine the behavior of the paths that transmit the shock from one pole to the other with regard to time. Three important considerations should be taken into account. First, there will be a range of time within which the influence will be transmitted. This can range from a very short to a very long period of time. If the slower paths do not take very much time, and if loops dissipate very quickly, then the full influence requires a finite range of time. Under this assumption, the influence of an economic shock on some group of people can be estimated within some range of time once we assume a cut-off value for the possible influence.

Second, the time required to transmit a shock highly depends upon the capacity of the paths associated with that shock. For example, if the capacity associated with the production of an agricultural product determines the amount of time that is required to transmit the influence, then any increase in the demand for that agricultural product will take time to accomplish due to the delay in the agricultural sector's ability to increase production. For the last consideration, we will use the term of the transformation process as a process through which inputs are transformed into outputs. In light of this, within the path between one pole to another, there are always three possibilities: (i) an instantaneous transformation, where the shock is transmitted instantly to the next path; (ii) a fixed-time transformation, where the transformation usually takes a definite amount of time, i.e., the time required from planting to harvesting; and (3) a flexible-time, which depends upon the available capacity and the transformation process.

In addition to that, instantaneous transformations happen in paths from virtual sectors to the real sectors. For example, all paths from factor income to an institution would be considered as having a zero time length. In order to avoid problems with capacity constraints, we would assume that SAM assumptions work properly as there is no capacity constraint in our model. By imposing this assumption, we would free ourselves from having to deal with the possibilities of shortages due to the capacity constraints embedded in one or more sectors. Moreover, we would also assume that during the time of influence transmission, prices will not change, and any increase/decrease of demands is translated fully to increase/decrease of goods and services production.

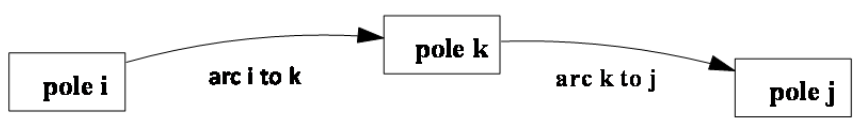
Fixed and flexible-time transformations are not foreign concepts in production management. A fixed-time transformation requires a definite time, no matter the size of the input in that transformation. For example, a time required to produce rice from its seeds basically remains constant at around 3-4 months and largely depends on the harvesting season. For the sake simplicity, in the 2008 Indonesian SAM, we impose a fixed-time transformation for all agricultural outputs, tax payments from households to the government, and any activities related to government activities.

On the other hand, a flexible-time transformation is determined by the size of its inputs. Assuming that a transformation process is constant, then the process time equals the quantity divided by the speed (defined as quantity per time). When we have a series of processes, i.e., one process followed by another, then the total time of that transformation will be the summation of the times required by each of the transformations. For example, if the time to produce 1,000 cars is 20 weeks, then as many as 50 cars are produced each week. If there is an increase in demand by 100 cars, then the time required to meet that additional will be two weeks.

In SPA, 'total influence' is defined as the product of all elementary path influences, which can consist of both direct and indirect effects. On the other hand, a global influence is a coefficient that results from inverting a SAM marginal expenditure matrix (or SAM coefficient matrix when using APC) with some exogenous accounts. For the sake of clarity, we begin by elaborating the SPA concept and then examine the inclusion of time in the SPA.

In the following explanation of the SPA and the theory that underpins the inclusion of time, we will begin by introducing the SPA. This explanation will follow the SPA developed by Defourny and Thorbecke, who define a 'path' as "a sequence of consecutive arcs" (1984, p. 119). A specific path p such as (i, k, j) consists of an arc from pole i to pole k as well as an arc from pole k to pole j. This path is represented by a subscript with arrows as in $X_{(i \to j)}$ with the additional subscript p, $X_{(i \to j)_p}$ or can be written as in $X_{(i,\ldots,j)}$ for transmission from pole i to pole j. For example, subscript (i, k, j) indicates the specific path from pole i to pole j through pole k.

Figure 2.3.1: The Path from Pole i to Pole j through Pole k Consisting Arc i to k and Arc k to j



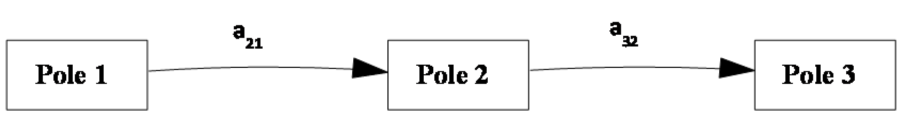
We define a_{ji} as a marginal expenditure from pole i to pole j. We use notation $I^D_{(i \to j)_p}$ for the direct influence from the pole i to the pole j along the path p. For example $I^D_{(i,k,j)}$ and $I^D_{(i,r,s,j)}$ correspond to the direct influence from pole i to pole j within the specific paths (i, k, j) and (i, r, s, j), respectively. The direct influence $I^D_{(i,..,j)}$

is defined as the change of income (production) of the pole j induced by the change of income (production) of the pole i with income (production) of every other pole remaining constant except for those in the path from pole i to pole j (Defourny and Thorbecke, p. 120). We also use notation $I^T_{(i\to j)_p}$ for the total influence from pole i to pole j within the specific path p. For example, $I^T_{(i,k,j)}$ and $I^T_{(i,r,s,j)}$ correspond to the total influence from pole i to pole j within the specific paths (i,k,j) and (i,r,s,j), respectively. The total influence $I^T_{(i,..,j)}$ is defined as the influence transmitted from the pole i to pole j through the specific path p, including all of the indirect effects embedded in the structure within the specific path p (Defourny and Thorbecke, p. 120). The notation I^G_{ji} is used for the global influence from pole i to pole j, which is essentially the sum of all possible total influences from pole i to pole j.

2.3.1. <u>SPA Methodology</u>

In Figure 2.3.1.1, we have a very simple structure with only three poles and no loops. The marginal expenditure from pole 1 to pole 2 and from pole 2 to pole 3 are identified with a_{21} and a_{32}, respectively.

Figure 2.3.1.1: The Path from Pole 1 to Pole 3 without any loops



A direct influence from pole 1 to pole 3, $I^{D}_{(1,2,3)}$ can be written simply:

$$I^{D}_{(1,2,3)} = a_{32}a_{21} \tag{2.3.1.1}$$

With a structure that has no loops, the value of the total influence is the same as that of the direct influence with a path multiplier that equals one.

Now, let us extend Figure 2.3.1.1 by adding one more path and introduce a loop between pole 2 and pole 3. With the new structure as in Figure 2.3.1.2, we can compute the direct influence:

$$I^{D}_{(1,2,3,4)} = a_{43}a_{32}a_{21} \tag{2.3.1.2}$$

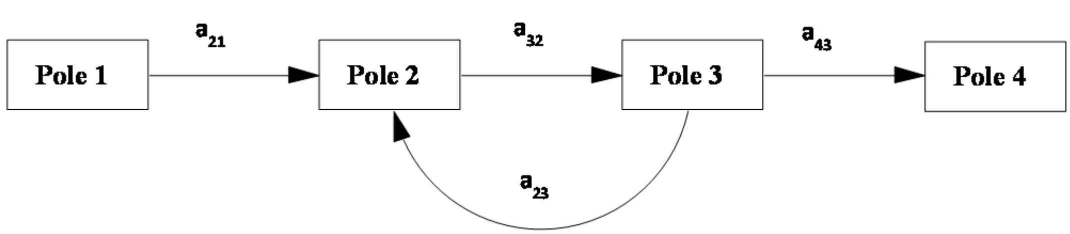
The total influence will be:

$$I^{T}_{(1,2,3,4)} = a_{43}(1 + a_{32}a_{23} + a_{32}^{2}a_{23}^{2} + a_{32}^{3}a_{23}^{3} + \cdots)a_{32}a_{21}$$

$$= a_{43}a_{32}a_{21}\left(\frac{1}{1-a_{32}a_{23}}\right) \tag{2.3.1.3}$$

The path multiplier is simply the ratio between the total influence and the direct influence. The second term in bracket in Equation (2.3.1.3) represents the path multiplier. It follows directly that the total influence is just the product of the direct influence and the path multiplier of the corresponding path.

Figure 2.3.1.2: The Path from Pole 1 to Pole 4 with 1 loop



Now with a more complex structure that has three paths and two loops, as in Figure 2.3.1.3, we can compute the direct influence, the total influence, and the path multiplier all in the same way. The total influence of the path $(1 \rightarrow 2 \rightarrow 3 \rightarrow 8)$ denoted by $I^T_{(1,2,3,8)}$, the path $(1 \rightarrow 5 \rightarrow 8)$ denoted by $I^T_{(1,5,8)}$, and the path $(1 \rightarrow 6 \rightarrow 8)$ denoted by $I^T_{(1,6,8)}$ are as follows in Equation (2.3.1.4), Equation (2.3.1.5), and Equation (2.3.1.6), respectively:

$$I^T_{(1,2,3,8)} = I^D_{(1,2,3,8)} . M_{(1,2,3,8)} = a_{83}a_{32}a_{21}\left(\frac{1}{1-a_{32}a_{23}}\right) \quad (2.3.1.4)$$

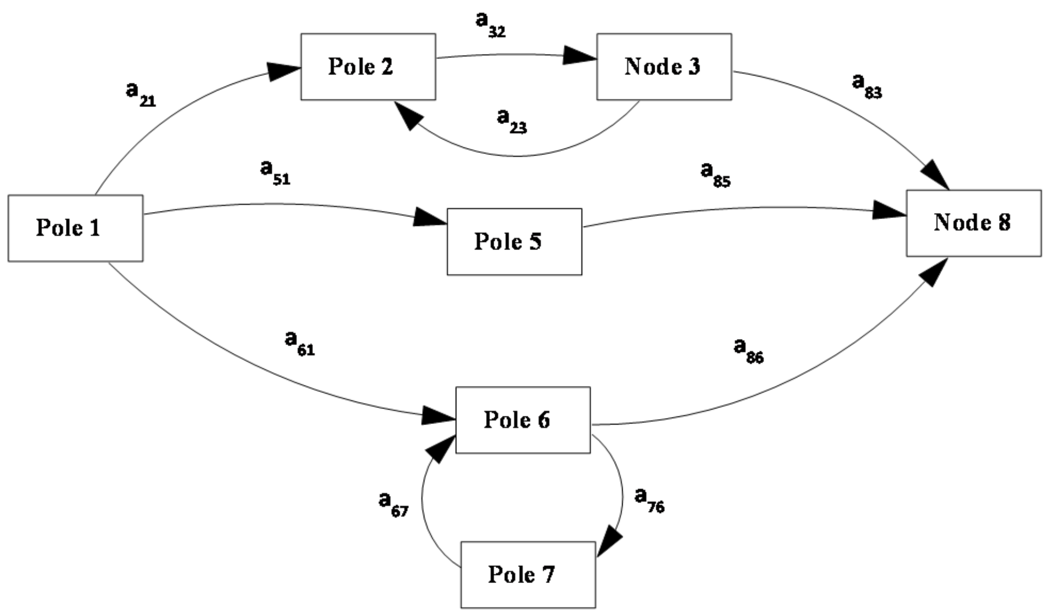
$$I^T_{(1,5,8)} = I^D_{(1,5,8)} = a_{85}a_{51} \quad (2.3.1.5)$$

$$I^T_{(1,6,8)} = I^D_{(1,6,8)} . M_{(1,6,8)} = a_{86}a_{61}\left(\frac{1}{1-a_{67}a_{76}}\right) \quad (2.3.1.6)$$

The global influence is the summation of all possible total influences from pole 1 to pole 8, which in this example is the summation of the total influence of the path $(1 \rightarrow 2 \rightarrow 3 \rightarrow 8)$, the path $(1 \rightarrow 5 \rightarrow 8)$ and the path $(1 \rightarrow 6 \rightarrow 8)$:

$$\begin{aligned} I^G_{81} &= I^T_{(1,2,3,8)} + I^T_{(1,5,8)} + I^T_{(1,6,8)} \\ &= a_{83}a_{32}a_{21}\left(\frac{1}{1-a_{32}a_{23}}\right) + a_{85}a_{51} + a_{86}a_{61}\left(\frac{1}{1-a_{67}a_{76}}\right) \end{aligned} \quad (2.3.1.7)$$

Figure 2.3.1.3: Pole 1 to Pole 8 with 3 Elementary Paths and 2 Loops



2.3.2. <u>Time Inclusion in SPA Methodology</u>

Referring back to Figure 2.3.1.1, we now assume that, in addition to the structure, we have a fixed-time transformation between poles 1 and 2, t_{f21}, and a flexible-time transformation between poles 2 and 3, t_{v32}. Since in poles 2 to 3, we have a flexible-time transformation, $v_{32} = X_{32}/t_{v32}$ represents input amounts per unit time between pole 2 and 3, which is essentially the total input on the path from pole 2 to pole 3, X_{32}, divided by the flexible-time required. The new structure can be seen in Figure 2.3.2.1.

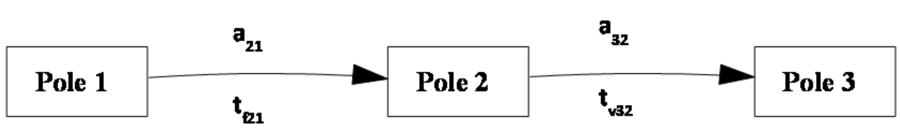
The time required to reach pole 2 is computed as a fixed-time transformation regardless of the size of the influence transmitted from pole 1 to pole 2, which then equals the fixed-time transformation from pole 1 to pole 2, t_{f21}. When we estimate the time required to reach pole 3, since pole 2 to pole 3 takes a flexible-time transformation, the time required for the influence to travel from pole 2 to pole 3 depends on the size of the influence transmitted from pole 1 to pole 2. If we assume that the original influence is *X*, then the input to pole 2 will be $a_{21}.X$ and the time required to process that will be:

$$t_{v32} = \frac{a_{21}.X}{v_{32}} \qquad (2.3.2.1)$$

Therefore, the total time required to reach pole 3 from pole 1 will be:

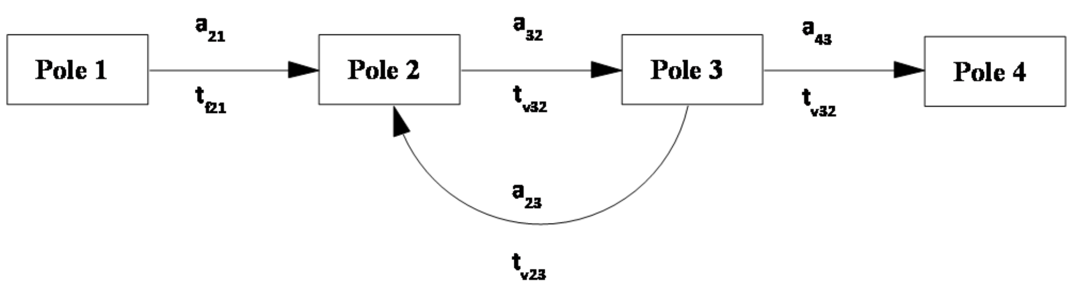
$$t_{1\rightarrow 2\rightarrow 3} = t_{f21} + t_{v32} = t_{f21} + \frac{a_{21}.X}{v_{32}} \qquad (2.3.2.2)$$

Figure 2.3.2.1: Direct Path from Pole 1 to Pole 3 without Any Loops



In the same way, we can compute the time in the structure as in Figure 2.3.1.2 by adding the time elements to it. Suppose that after adding the time elements, it then becomes as in the Figure 2.3.2.2. We can assume that there is a fixed-time transformation between pole 1 and pole 2 while all other arcs are inhibiting the flexible-time transformations. Let us assume also that there is an input which has the value of money X.

Figure 2.3.2.2: Path from Pole 1 to Pole 4 with One Loop and Specified Time between the Poles Added



Since the time added between pole 1 and pole 2 is a fixed-time transformation which does not depend on the input to pole 1, the time required from pole 1 to pole 2 is fixed at t_{f21}units of time. The time required to reach pole 3 from pole 1 can be computed as follows:

$$t_{(1,2,3)} = t_{f21} + \frac{a_{21}X}{v_{32}} + \frac{a_{32}a_{21}X}{v_{23}} + \frac{a_{32}a_{21}^2X}{v_{32}} + \frac{a_{32}^2a_{21}^2X}{v_{23}} + \cdots \qquad (2.3.2.3)$$

The infinite series beginning with the second term of (2.3.2.3) can be simplified further so that Equation (2.3.2.3) becomes Equation (2.3.2.4):

$$t_{(1,2,3)} = t_{f21} + \left(\frac{a_{21}}{v_{32}} + \frac{1}{v_{23}}\right)\left(\frac{1}{1-a_{32}a_{21}}\right)X \qquad (2.3.2.4)$$

The last time piece is from the pole 3 to pole 4, which depends on the size of input to pole 3:

$$t_{(3,4)} = \left(\frac{1}{v_{43}}\right)\left(\frac{1}{1-a_{32}a_{23}}\right)a_{32}a_{21}X \qquad (2.3.2.5)$$

Combining Equations (2.3.2.4) and (2.3.2.5), we can compute the time required from pole 1 to pole 4 as the summation of the time required from pole 1 to pole 3 and from pole 3 to pole 4:

$$t_{(1,2,3,4)} = t_{(1,2,3)} + t_{(3,4)}$$

$$= t_{f21} + \left(\frac{a_{21}}{v_{32}} + \frac{1}{v_{23}}\right)\left(\frac{1}{1-a_{32}a_{21}}\right)X + \left(\frac{1}{v_{43}}\right)\left(\frac{1}{1-a_{32}a_{23}}\right)a_{32}a_{21}X \qquad (2.3.2.6)$$

Next, we work with the structure (2.3.1.3) with time imposed in each of its arcs as can be shown in Figure 2.3.2.3. This simply combines all of the structures we had before with additional required time attached. The time required for the first path $(1 \rightarrow 2 \rightarrow 3 \rightarrow 8)$ is the same as in Equation (2.3.2.6) and the required time for the second path $(1 \rightarrow 5 \rightarrow 8)$ is the same as in Equation (2.3.2.2).

The third path $(1 \rightarrow 6 \rightarrow 8)$ with a loop at pole 6 can be computed the same way as before. Denoting the input to pole 1 as X, we find that the size of the input to pole 6 is $a_{61}X$. When the influence reaches pole 8, the size of this influence follows Equation (2.3.1.6). The time required for this path can be computed as follows:

$$t_{(1,6)} = \frac{a_{61}X}{v_{61}} \qquad (2.3.2.7)$$

$$t_{(6,8)} = \left(\frac{a_{86}}{v_{86}} + \left[\frac{a_{76}}{v_{76}} + \frac{a_{67}a_{76}}{v_{67}} + \frac{a_{86}a_{67}a_{76}}{v_{86}}\right] + \left[\frac{a_{67}a_{76}^2}{v_{76}} + \frac{a_{67}^2a_{76}^2}{v_{67}} + \frac{a_{86}^2a_{67}^2a_{76}^2}{v_{86}}\right] + \right.$$

$$\left.\left[\frac{a_{67}^2a_{76}^3}{v_{76}} + \frac{a_{67}^3a_{76}^3}{v_{67}} + \frac{a_{86}^3a_{67}^3a_{76}^3}{v_{86}}\right] + \cdots\right)a_{61}X \qquad (2.3.2.8)$$

Equation (2.3.2.8) can be simplified further into Equation (2.3.2.9):

$$t_{(6,8)} = \left(\frac{a_{86}}{v_{86}} + \frac{a_{76}}{v_{76}} + \frac{a_{67}}{v_{67}}\right)\left(\frac{1}{1-a_{67}a_{76}}\right) a_{61}X \qquad (2.3.2.9)$$

We can rewrite the total time required for path 1 – 2 – 3 – 8 as in Eq. (2.3.2.10), path 1 – 5 – 8 as in Eq. (2.3.2.11). Combining Equation (2.3.2.8) and Equation (2.3.2.9), we have Equation (2.3.2.12) which represents the time required of the path 1 – 6 – 8:

$$t_{(1,2,3,8)} = t_{f21} + \left(\frac{a_{21}}{v_{32}} + \frac{1}{v_{23}}\right)\left(\frac{1}{1-a_{32}a_{21}}\right) X + \left(\frac{1}{v_{83}}\right)\left(\frac{1}{1-a_{32}a_{23}}\right) a_{32}a_{21}X \qquad (2.3.2.10)$$

$$t_{(1,5,8)} = t_{f51} + \frac{a_{85}.X}{v_{85}} \qquad (2.3.2.11)$$

$$t_{(1,6,8)} = \left[1 + \left(\frac{a_{86}}{v_{86}} + \frac{a_{76}}{v_{76}} + \frac{a_{67}}{v_{67}}\right)\left(\frac{1}{1-a_{67}a_{76}}\right)\right] a_{61}X \qquad (2.3.2.12)$$

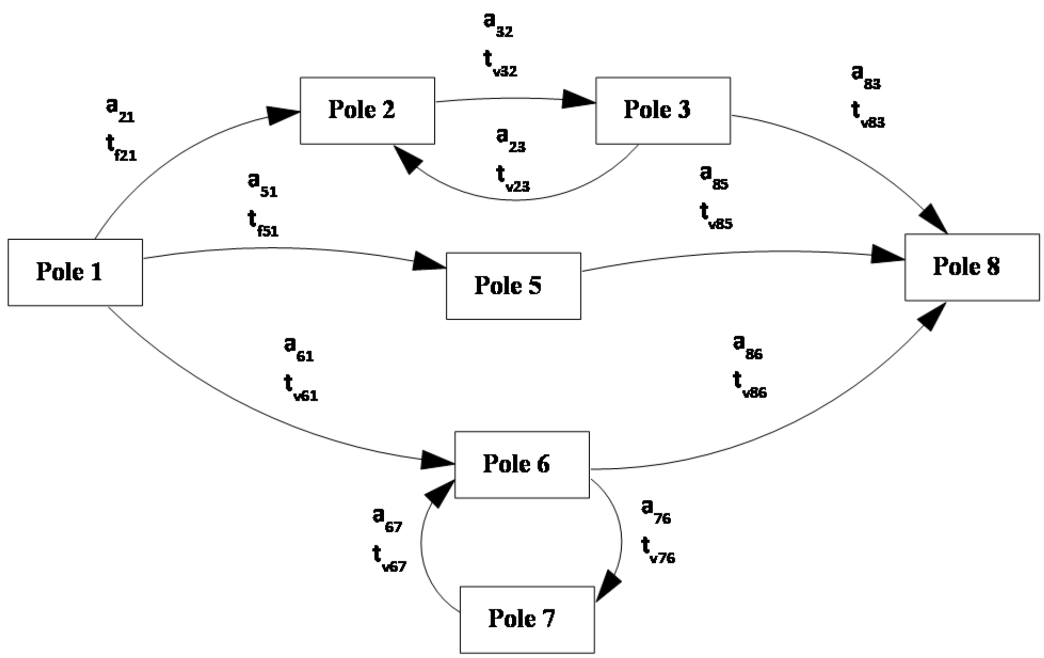
The time required from pole 1 to pole 8 is the maximum time from pole 1 to pole 8 through every possible path:

$$t_{81} = max\{t_{1\to2\to3\to8}, t_{1\to5\to8}, t_{1\to6\to8}\}$$

$$= max\left\{t_{f21} + \left(\frac{a_{21}}{v_{32}} + \frac{1}{v_{23}}\right)\left(\frac{1}{1-a_{32}a_{21}}\right) X + \left(\frac{1}{v_{83}}\right)\left(\frac{1}{1-a_{32}a_{23}}\right) a_{32}a_{21}X,\ t_{f51} + \frac{a_{85}.X}{v_{85}},\right.$$

$$\left.\left[1 + \left(\frac{a_{86}}{v_{86}} + \frac{a_{76}}{v_{76}} + \frac{a_{67}}{v_{67}}\right)\left(\frac{1}{1-a_{67}a_{76}}\right)\right] a_{61}X\right\} \qquad (2.3.2.13)$$

Figure 2.3.2.3: Pole 1 to Pole 8 with 2 Possible Direct Paths

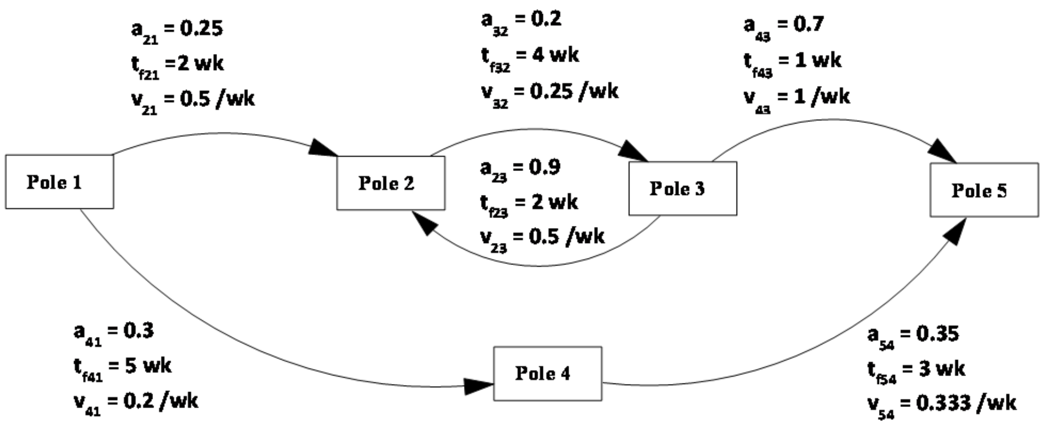


After the first several loops, however, the effects generally become very small. The following two imaginary examples will compare and compute the time required from the origin pole to the destination pole.

2.3.3. <u>An Example of Fixed-time and Flexible-time Transformation</u>

Suppose we have the following structure, as shown in Figure 2.3.3.1, with two main paths from pole 1 to pole 5 and there is a shock from pole 1 of as much as $1B. The time notation follows the same notation as in the previous section with subscript f indicating the fixed-time transformation, subscript v indicating the flexible-time transformation, and v_{ji} indicating the speed of the transformation. In each arc, the fixed-time transformation and the speed of transformation associated with the flexible-time transformation are posted.

Figure 2.3.3.1: Pole 1 to Pole 5 with 2 Possible Direct Paths with 1 Loop



We will examine the size of the influences transmitted along each path and compute those influences. Table 2.3.3.2 shows that the influence becomes smaller as the it is transmitted through more loops. For example, a shock moving from pole 1 to pole 5 through poles 2 and 3 results in influence of \$35M (since $(0.25)(0.2)(0.7)(1) = 0.035$). Continuing in that way, by the third loop, the change in the influence transmitted at the third loop is only 0.02% of the original influence of \$1B or just around \$0.2M.

Table 2.3.3.2: Pole 1 to Pole 5 Influence Size through Path 1 – 2 – 3 – 5 after 1st, 2nd, and 3rd Pass on the Loops and Direct Influence through Path 1 – 4 – 5

No.	Paths	Influence (%)
1	1 - 2 - 3 - 5	3.50%
2	1 - 2 - 3 - 2 - 3 - 5	0.63%
3	1 - 2 - 3 - 2 - 3 - 2 - 3 - 5	0.11%
4	1 - 2 - 3 - 2 - 3 - 2 - 3 - 2 - 3 - 5	0.02%
5	1 - 4 - 5	10.50%

The first approach uses a fixed-time transformation where time does not depend on inputs. In this first approach, when the influence travels n times on the same path, then the time required is simply the product of n and the amount time required for a single pass along that path. The second approach differs from the first in that time depends on the inputs. When the input to one specific path is smaller, then the time required to transmit the influence will be shorter too.

A fixed-time transformation requires much more time to transmit the influence than a flexible-time transformation; a flexible-time transformation requires time in line with the inputs which reduces significantly once the first pass has been completed. The fixed-time transformation of path $1 \rightarrow 2 \rightarrow 3 \rightarrow 5$ is $t_{21} + t_{32} + t_{53} = 2 + 4 + 1 = 7$ weeks. With one loop and fixed-time transformation $(1 \rightarrow 2 \rightarrow 3 \rightarrow 2 \rightarrow 3 \rightarrow 5)$, the computation is $t_{21} + t_{32} + t_{23} + t_{23} + t_{53} = 2 + 4 + 2 + 4 + 1 = 13$ weeks. If we assume flexible-time, then the path $(1 \rightarrow 2 \rightarrow 3 \rightarrow 5)$ is computed as $\frac{1}{v_{21}} + \frac{a_{21}}{v_{32}} + \frac{a_{21}a_{32}}{v_{53}} = 2.1075$ weeks. With one loop and the fixed-time transformation $(1 \rightarrow 2 \rightarrow 3 \rightarrow 2 \rightarrow 3 \rightarrow 5)$, the time required for this path is computed as $\frac{1}{v_{21}} + \frac{a_{21}}{v_{32}} + \frac{a_{21}a_{32}}{v_{23}} +$

$\frac{a_{21}a_{32}a_{23}}{v_{32}} + \frac{(a_{32})^2 a_{23}a_{21}}{v_{53}} = 2.2936$ weeks. The rest can be seen in Table (2.3.3.2). After the first three loops, the additional time in a flexible-time transformation decreases significantly.

Table 2.3.3.3: Pole 1 to Pole 5 under Fixed- and Flexible-Time Transformations

No.	Paths (pole-*i* - pole-*j*)	Under Fixed-time	Under Flexible-time
1	1 - 2 - 3 - 5	7	2.1075
2	1 - 2 - 3 - 2 - 3 - 5	13	2.2936
3	1 - 2 - 3 - 2 - 3 - 2 - 3 - 5	19	2.3214
4	1 - 2 - 3 - 2 - 3 - 2 - 3 - 2 - 3 - 5	25	2.3277
5	1 - 4 - 5	8	5.9

2.3.4. Estimating the Minimum and Maximum Time

As shown in the example above, under the fixed-time transformation, time from one pole to another can simply be a sum; however, since we know that the influence size reduces significantly after the first few loops, we can establish some cut-off time for the loops in the fixed-time transformation under which the influence is no longer significant. That is what we will find in this second example. The time allocation for each arc in our previous example can be put into the form of a two-dimensional matrix where the each entry a_{ij} refers to marginal expenditure propensity from sector-*i* to sector-*j* as can be seen in the following matrix in Table 2.3.4.1:

Table 2.3.4.1: Marginal Expenditure Matrix

A	sector 1	sector 2	sector 3	sector 4	sector 5
sector 1	0	0	0	0	0
sector 2	0.25	0	0.9	0	0
sector 3	0	0.2	0	0	0
sector 4	0.1	0	0	0	0
sector 5	0	0	0.7	0.35	0

In the above matrix, the point (sector 2, sector 1) represents the marginal expenditure from sector 1 to sector 2, which in this case has the value of 0.25; likewise, the point (sector 3, sector 2) represents the marginal expenditure from sector 2 to sector 3, which in this case has the value of 0.2.

Using the same procedure, we can embed time in the form of a matrix as well for both the fixed-time transformation and the flexible-time transformation. The following matrix in Table 2.3.4.2 represents the fixed-time transformation matrix. For example, point (sector 2, sector 1) represents a fixed-time transformation from sector 1 to sector 2, and point (sector 2, sector 2) represents a fixed-time transformation from sector 2 to sector 3, which in this case are 2 and 4 weeks, respectively.

Table 2.3.4.2: Fixed-Time Transformation Matrix

Fixed Time	sector 1	sector 2	sector 3	sector 4	sector 5
sector 1	0	0	0	0	0
sector 2	2	0	2	0	0
sector 3	0	4	0	0	0
sector 4	5	0	0	0	0
sector 5	0	0	1	3	0

To compute the flexible time transformation matrix, we must assign each non-zero cell the value of the rate of change by dividing it by the amount of time required to accomplish the job, $v_{ji} = 1/t_{ji}$ for any poles i to poles j. Table 2.3.4.3 represents the flexible-time transformation matrix constructed for our example. For example, point (sector 2, sector 1) represents a flexible-time transformation from sector 1 to sector 2, point (sector 2, sector 2) represents a flexible-time transformation from sector 2 to sector 3, which in this case are 0.5 and 0.25 units per week, respectively.

Table 2.3.4.3: Flexible-Time Transformation Matrix

Var. Time	sector 1	sector 2	sector 3	sector 4	sector 5
sector 1	0	0	0	0	0
sector 2	0.5	0	0.5	0	0
sector 3	0	0.25	0	0	0
sector 4	0.2	0	0	0	0
sector 5	0	0	1	0.33	0

By applying the SPA method, we can compute the direct effects, path multipliers, total effects, and global effects. The results are shown in Table 2.3.4.4:

Table 2.3.4.4: SPA Results of the Example

Paths	Direct Influence	Path Multiplier	Total Influence	Global Influence
1, 2, 3, 5	0.035	1.220	0.043	0.078
1, 4, 5	0.035	1.000	0.035	0.078

We can then think of the path multiplier p as a convergent infinite series with a multiplicative factor r, which has a value of less than one by the simple formula:

$$m = \frac{(p-1)}{p} \qquad (2.3.4.1)$$

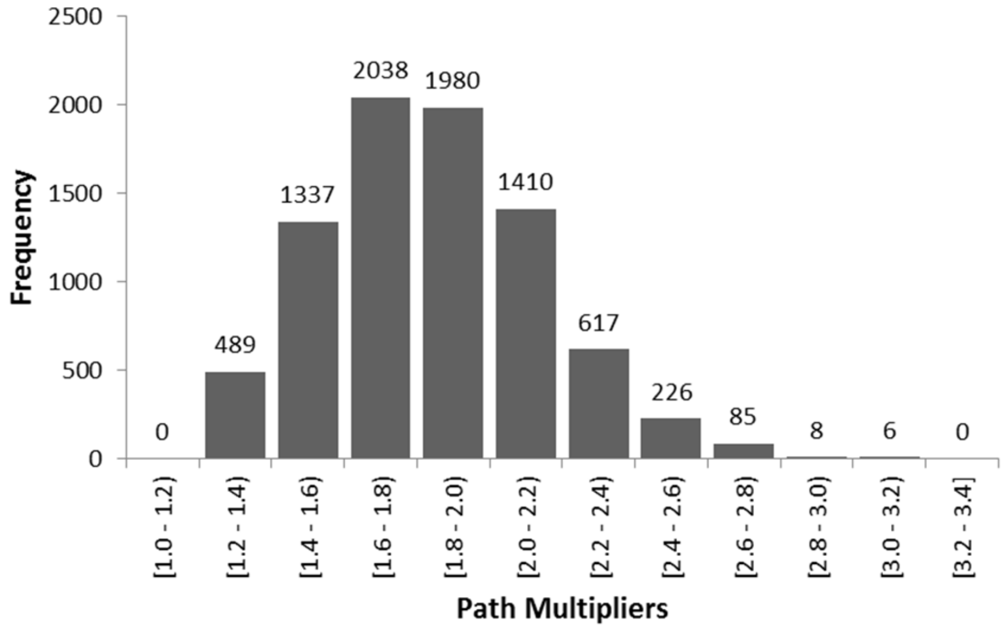
For example, a path multiplier of 0.035 can be restated as a simple infinite convergent series with a multiplicative factor of 0.18. With less than 3 loops, the summation of the series reaches more than 95% of its total effect.

Table 2.3.4.5: The Sum Series of the Path Multiplier (1, 2, 3, 5)

Number of pass	Series	Sum	% total
1st	1.0000	1.0000	82.00%
2nd	0.1800	1.1800	96.76%
3rd	0.0324	1.2124	99.42%
4th	0.0058	1.2182	99.90%
5th	0.0010	1.2193	99.98%

Table 2.3.4.5 shows that when the influence passes the same loop for the second time, the total influence of that route increases to more than 95% of the total influence. When the consumption block's path multipliers are examined, more than 90% are between 1.0 and 2.2, and more than 95% are between 1.2 and 2.4. Accordingly, around 80% of the path multipliers lie between 1.4 and 2.2. This implies that when running the whole route two or three times, the influence equals more than 75% of the total influence. Running the whole path four times guarantees more than 90% of the total influences. Therefore, we can use the path multiplier to compute the maximum time for flexible-time transformation. Figure 2.3.4.1 shows the distribution of the path multipliers from the consumption block in SAM 2008, which fall well within the range of 1.2 to 3.2.

Figure 2.3.4.1: Distribution of Path Multipliers of the Consumption Block of SAM 2008



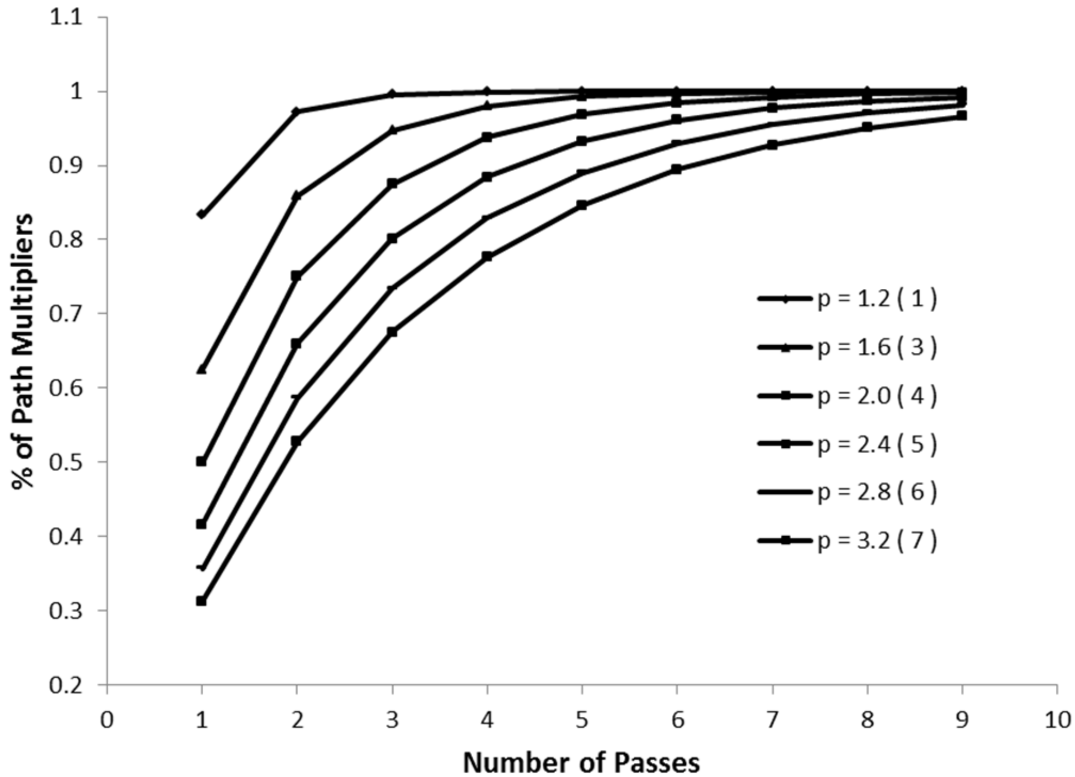
The maximum time for the fixed-time transformation in this example is computed with the loops were passed through for just few times. For flexible-time transformations, we can create a range within which the maximum time will follow the size of the influence when it reaches at least 95% of the total influence. In the same way, determining the maximum time as the direct flexible-time multiplied by the number of passes through that path, which in this case is two times, the flexible time equals 4.2 weeks. The result of the computation is shown in Figure 2.3.4.1. Therefore, the maximum time from pole 1 to pole 5 ranges from 8 (without loops) to 14 weeks (with loops) under the fixed-time transformation and from 2.1 (without loops) to 5.9 weeks (with loops) under the flexible-time transformation.

Table 2.3.4.6: Minimum and Maximum Time of the Example

Paths	Time Required for Direct Influence		Max Time for 95% Total Influence	
	Fixed Time	Flexible Time	Fixed Time	Flexible Time
1, 2, 3, 5	7.0	2.108	14.0	4.215
1, 4, 5	8.0	5.900	8.0	5.900

The question of how many passes are required for one specific path to reach 95% of its total influence is related to the path multiplier of that specific path. Based on the SAM 2008, path multipliers between 1 and 3.2 will require periods of between 1 to 8 passes. This can be seen in Figure 2.3.4.2, which shows how the increase of path multipliers requires more periods in order to reach significantly higher than 95% of the total influences. The number in brackets indicates the number of loops that must be passed in addition to the direct path. For example, $p = 1.2\ (1)$ indicates that the path multiplier value of 1.2 requires at least one pass through the loop in order to reach more than 95% of its total influence. In general, for the Indonesian SAM 2008, one to five passes through the loops are needed in order to reach at least 95% of the total influences.

Figure 2.3.4.2: Path Multipliers and Periods to Required Reach More than 95% of Total Influences



2.3.5. Imposing Time Value of Money

Let the interest rate in the economy in this example be 10% annually. If all computations use weeks, then we can compute the decline of value caused by this shock transmission. Assuming that interest is compounded on a weekly basis, we can compute the interest on a weekly basis by using this simple formula:

$$i = e^{r.t} - 1 = e^{0.1.t} - 1 \qquad (2.3.5.1)$$

Interest rate, i, here is the yearly effective interest rate, and r is the annual interest rate with t as its compounding period. Taking the maximum (95% influence) fixed-time transformation, we can employ $t = 14/52$ and $t = 2.57/52$ for the maximum flexible time. The computed discount rates equal 2.73% and 0.50% for fixed- and flexible-time, respectively. Therefore, under a fixed-time transformation, when there is a shock of $1B in sector 1, it will arrive at sector 5 in the amount of as much as $0.043B through poles 1 – 2 – 3 – 5 with the present-value of $0.0415B dollars in roughly 14 weeks, delivering more than 95% of its full influences.

2.3.6. Agricultural and Manufacturing Sectors in Indonesian Economy

The agricultural sector plays a very important role in contributing to the Indonesian economic development. Since the 1960s, Indonesia has experienced vast economic growth in all economic sectors. According to Thorbecke and Pluijm (1993),[2] agriculture plays four important roles in Indonesian economic development. First, agriculture provides food and raw materials for sectors that rely on it; thus, it contributes to the GDP growth. Second, agriculture provides "productive employment opportunities" and income for people who live in rural areas. Third, it reduces malnutrition and provides structures of production that enable small farmers and landless agricultural workers to share the benefits of agricultural growth. Lastly, the agricultural sector can help boost the exports which in turn would improve the country's balance of payment.

[2] Thorbecke, Erik and Theodore van der Pluijm use SAM from various years to examine Indonesian rural socio-economic development.

The phase of industrialization in Indonesia was driven by agricultural-based industries, which were built to exploit the low-cost of labor and the potential supply of domestic agricultural products. As can be seen in Table 2.3.6.1, during the nation's four decades of economic development, the manufacturing sector has grown its share of the economy more rapidly than other sectors. In contrast, the mining sector has reduced its share drastically. The development of the manufacturing sector has been accompanied by the development of the financial and service sectors too, which commonly happens in industrialized countries throughout the world.

Table 2.3.6.1: Distribution of GDP from the 1960s to 2000s

	60s	70s	80s-90s	2000s
1. Agriculture, Livestock, Forestry, & Fishery	54.0	35.6	20.5	15.0
2. Mining and quarrying	3.5	15.2	15.7	9.8
3. Manufacturing Industry	8.2	9.4	18.1	28.8
4. Electricity, Gas and Water Supply	0.2	0.5	0.6	0.8
5. Construction	1.9	4.4	5.7	5.8
6. Trade, Hotel and Restaurant	15.9	17.0	16.0	16.2
7. Transport & Communication	2.5	4.1	5.9	5.5
8. Financial, ownership and business	2.7	3.6	6.8	8.3
9. Services	11.0	10.2	10.7	9.6

Source: Authors' calculation on BPS's National Account Statistics

The oil industry boom from the early 1970s to the mid 1980s also contributed to the vast growth of the Indonesian economy. The relatively low price of domestic oil and gas boosted the demand and increased the consumption of goods and services, which in turn fed the growth of the manufacturing industry. The low price of oil and gas were been maintained by the government to aid industrial growth and stable socio-political conditions, but this came at at the cost of a continual increase in the burden of subsidies. Several efforts to reduce or eliminate such subsidies always exacerbated the restlessness of the people as general price increases followed almost instantly. Azis (2009) showed that many important sectors were affected and eventually reduced their employment, which brought grater hardship to the low-income group.

Public sector growth also contributed to higher economic growth. According to Sundrum (1986), higher public sector growth was more likely caused by higher payments (salaries) than by higher productivity. Improvements in labor productivity were also driven by the movement of laborers from low-productivity jobs to higher-productivity ones. In line with it, the significant build-up of capital investment also enhanced the technology used in raw material processing in Indonesia. This in turn led also to higher labor productivity growth. In general, there have been some structural changes in the Indonesian economy that can be seen from the composition of Indonesia's GDP. The manufacturing and mining sectors' shares of the GDP continued to increase along with the financial and service sectors especially since 1980s, thereby changing the structure of the Indonesian economy.[3]

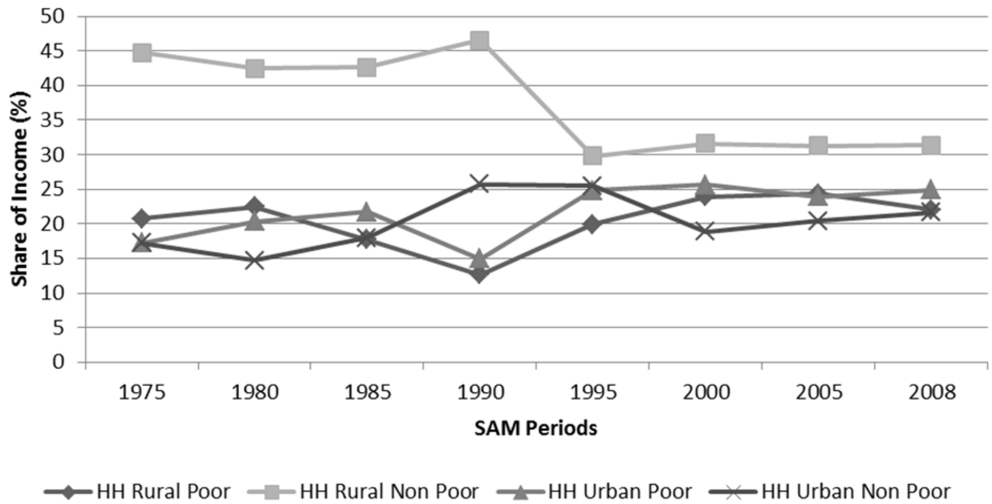
Though Indonesian economic growth increased people's general standard of living, it also created another social problem – namely, an increase in inequality throughout the country. During the period from 1975 to 1985, the relative distribution of the income among different households has not improved much (Fig. 2.3.6.1). Only non-poor urban household experienced a significant increase of income from just around 15% to more than 25%, while the rest remained largely the same. The improvement started to take effect in the early 1990s when the amount of non-poor

[3] SAM and supporting data in this paper are taken from various months of *Badan Pusat Statistik* (BPS) and *Statistik Ekonomi Keuangan Indonesia, Bank Indonesia*.

rural households dropped drastically from more than 45% to only slightly above 30%. At the same time, the amount of the poor households increased from below 15% to well above 20%.

As explored by Azis (1997), Booth (2000), Mishra (2009) Resosudarmo and Vidyatama (2006), and D’Silva and Bysouth (1992), the income inequality has worsened during the 1990s even before the financial crisis. The recent financial crisis in 1997-1998 slightly reduced the income inequality because many people lost their wealth. Since 2005, the economic growth was rebound again and had relatively grew faster though still with the worsening of income inequality as indicated by the the worsening of the Gini coefficients again. Several efforts have been made by the government to reduce this inequality introducing a tax hike for high-income people, a cross-subsidy of oil and gas prices, direct transfers to the poor, and some social programs for education and health. Though these programs are somewhat effective, they are simply not effective enough due to the lack of funds and the presence of rampant corruption in the execution of these programs.

Figure 2.3.6.1: Distribution of Income Based on SAM 1975 - 2008



2.4. Results of SPA with Time: Indonesian Case

Two cases will be discussed: (1) agricultural crop sectors, and (2) the effects of oil-intensive sectors on the population. The former relates to food crops sector, and the latter is related to the chemical and metallic sectors. We will analyze the paths by which the influence (direct and total) travels to different households. In addition, we will assume an interest rate of 8.5% based on the average of interest rate in 2008.[4] We will use this rate to compute the present value of the various influences involved in our case an in our computation process.[5]

[4] The average is computed according to the 12-month interest rate of demand deposit in 2008 based on Bank Indonesia data.

[5] We developed the software program used for the inclusion of time in the SPA using Matlab program that was based on the program developed by John Zollweg for the purpose of the Cornell Project about Cornell's impact on the community.

2.4.1. Transmission of Influence from Agriculture Crop Sector to Farm Workers

For the purpose of illustration, we will take only the direct effects that are greater than 0.0001 and the paths that have the longest direct time paths. These paths are included is to illustrate the time required to reach the destination.

The following description is based on Figure 2.4.1.1. In that figure, we use the following abbreviations: *AgWRu* for agricultural workers in rural area who receive wages, *AgWUr* for agricultural workers in urban areas who receive wages, *AgNWRu* for agricultural workers in rural areas who receive no wages, *AgNWUr* for agricultural workers in urban areas are who receive no wages, *CAP* for factor of capital, *FarmEn* for farm entrepreneur households, *Ent* for enterprises, *Gov* for government, *DCAgFish* for domestic commodities of agricultural fishery, and *SAgFish* for the agricultural fishery sector. A complete list of all abbreviations used in all graphs and tables can be found in Appendix (A). All factor payments from the agricultural crop sector (*SAgCrop*) take 16 weeks because planting and harvesting require 4 months on average. Payment from factors to institutions happens instantaneously, which means that no time is required to transmit institution income. As we can see, the shortest time is 16 weeks and the longest is 76. Much of the influence is transmitted directly from *SAgCrop* to various factors before arriving at the farm labor households (*FarmL*) (Fig. 2.4.1.1). Using the interest rate of 8.5%, the present value of every rupiah received by the farm worker household is between 0.877 and 0.987 thousand rupiah.

Figure 2.4.1.1: Paths from Agriculture Crop Sector to Farm Workers

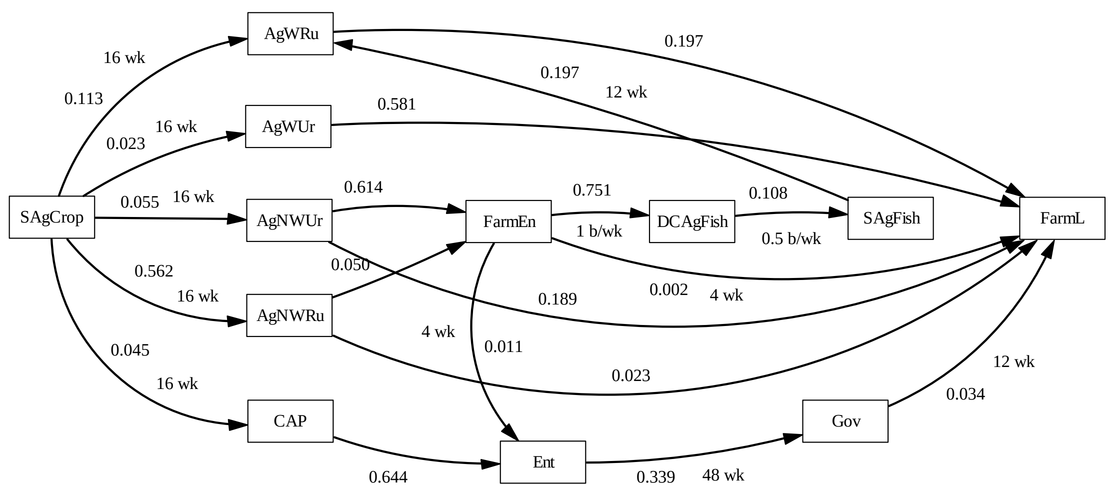


Table 2.4.1.1: SPA and Time Related to Transmission of Influences from Agricultural Crop Sector to Farm Workers

	Effects			Direct Time		Max Time		%tage
Paths	Direct	Total	Path mult	Fixed	Mixed	Fixed	Mixed	of Global
SAgCrop - AgWRu - FarmL	0.0223	0.0297	1.3353	16.00	16.00	48.00	48.00	25.1%
SAgCrop - AgWUr - FarmL	0.0135	0.0177	1.3125	16.00	16.00	48.00	48.00	14.9%
SAgCrop - AgNWRu - FarmL	0.0128	0.0174	1.3582	16.00	16.00	48.00	48.00	14.7%
SAgCrop - AgNWUr - FarmL	0.0104	0.0137	1.3136	16.00	16.00	48.00	48.00	11.6%
SAgCrop - AgNWUr - FarmEn - Gov - FarmL	0.0000	0.0000	1.8496	32.00	32.00	128.00	128.00	0.0%
SAgCrop - CAP - Ent - Gov - FarmL	0.0003	0.0007	2.1069	76.00	76.00	380.00	380.00	0.6%
SAgCrop - DCAgLivSt - SAgLivSt - AgNWRu - FarmL	0.0002	0.0002	1.4799	20.00	19.82	60.00	59.46	0.2%
SAgCrop - AgNWRu - FarmEn - DCTextLeath - STextLeath - PrWRu - FarmL	0.0000	0.0000	2.0138	23.00	22.74	115.00	113.69	0.0%
Global Multiplier	0.1183							

When we use all the direct paths with the minimum of 0.0001 influence size, the cumulative total influence is only 57% of the global influence. This means that many of the influences travel through various loops and various other paths whose direct influences are less than 0.0001.[6] Table 2.4.1.1 shows that the longest time path has a total influence of only 0.001 or just 0.1% of the global influence but takes between 80 and 400 weeks to fully transmit that influence. Every rupiah received by farm labor has the present value of only between 0.52 and 0.88 rupiah. These rupiah values contain more than 95% of the total influence, which is generally achieved after a few loops.

If we are just interested in direct influences, as shown in Figure 2.4.1.2, farm labor receives around 50% of the global effect within just 16 weeks, while the remaining 7% is spread over a period of 60 weeks. Meanwhile, if we also include the loops, then the cumulative total influence reaches around 78% of the global effect, and 68% of the global influence is achieved in less than a 50-week period with the remaining 10% spread out over a period of 350 weeks. The graph shows all significant direct and total influences that travel from the agricultural crop sector to farm workers. This suggests the range of time within which the influences will reach certain percentages of global influence. Within 20 weeks of the initial shock, the direct influence will increase to around 50% of the global influence; however, it will takes another 30 weeks for the total influence to reach 95% of its total influence for some specific paths. Table 2.4.1.2 provides a summary of time and influence. Here, we define the mixed-time transformation as the combination o fixed- and flexible-time transformation. Interestingly, the minimum and maximum time under both fixed- and mixed-time transformation are relatively not different.

[6] There are actually many more direct impacts than are presented here; the direct impacts are greater than 0.0001, but we only present those few paths that are significant in term of size and time.

Figure 2.4.1.2: Required Time for Direct and Total Influences to Travel from Agricultural Crop Sector to Farm Workers

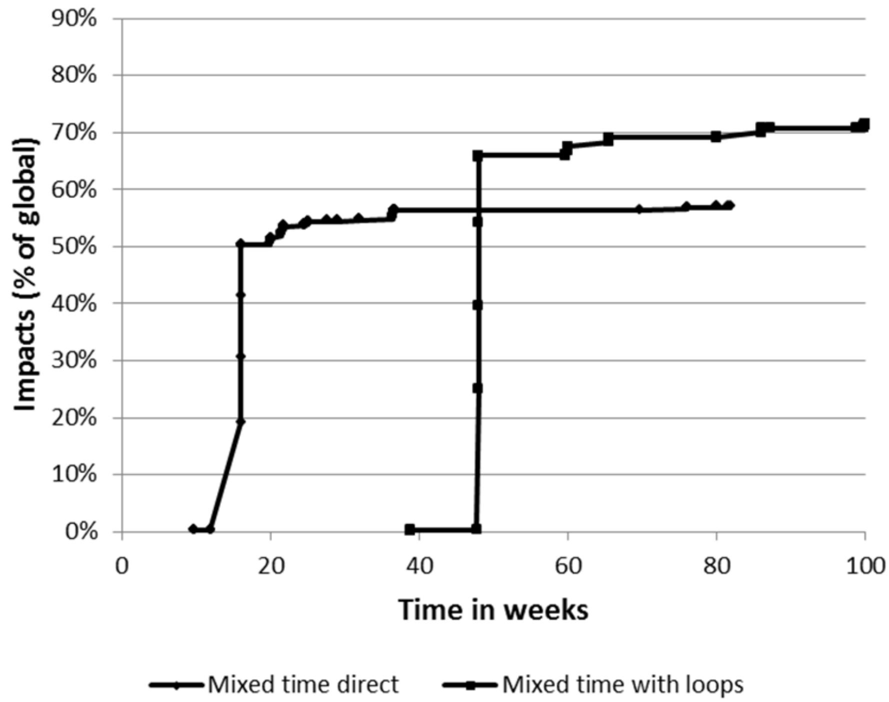


Table 2.4.1.2: Time Summary of Agricultural Crop to Farm Workers

Total of significant direct paths (> 0.00001)	Time (weeks) min	average	max	Impact % Global
Fixed time (w/o loops)	8.0	28.7	80.0	56.9%
Fixed time (incl. loops)	32.0	120.4	560.0	78.2%
Mixed time (w/o loops)	7.7	28.5	80.0	56.9%
Mixed time (incl. loops)	30.8	119.3	556.5	78.2%

According to Table 2.4.1.1, in the transmission of influences, the government may serve as a possible bottleneck due to the rigid structure of the government budget, which is either based on a yearly or quarterly basis.

2.4.2. Transmission of Influence from Agricultural Crop Sector to Various Households

When we plotted all of the times required for the initial direct influences to be transmitted from the agricultural crop sector to the households, we found that farm entrepreneurs and farm labor were the two households that received the highest direct influences under certain periods of time (Fig. 2.4.2.1). Here, we use the following abbreviations: *FarmL* for farm labor, *FarmEn* for farm entrepreneur, *HiEnUr* for high-urban entrepreneur, *HiEnRu* for high-rural entrepreneur, *LoEnUr* for low-urban entrepreneur and *LoEnRu* for low-rural entrepreneur. These abbreviations will be used in all of the subsequent graphs and tables. According to our findings, all households receive most of their direct influences within 30 weeks from the initial shock with the lowest influences (about 25%) being received by the high-urban entrepreneurs and the highest influences (about 64%) being received by farm entrepreneurs.

However, using threshold of 95% of the total influence, we estimate that much of the indirect influences are transmitted from around 60 to 150 weeks (Fig. 2.4.2.2). Again, we see that farm entrepreneurs receive the most benefit of the influences in the shortest period of time, i.e., within a 60-week period. In contrast, all of the urban entrepreneur households receive the smallest fraction of the total influences as well as the longest period of time, i.e., around 150 weeks. The two graphs reveal almost the same patterns regarding which households are most affected within a certain time period. The influences in both graphs dramatically increase after a certain period of time (20-60 weeks). Here, we graph all the possible timelines through all possible paths from agricultural sector to households. The dramatic increase of the impacts reveals that in almost all of the paths, the transmission of influences accelerates between 20 and 60 weeks, after which it begins to decelerate again.

Considering the time required to transmit the influences, by defining the mixed-time transformation as the combination of fixed- and flexible-time transformation, Tables 2.4.2.1 and 2.4.2.2 show the results under fixed- and flexible-time transformation, respectively. The fixed-time approach shows a slightly higher minimum, average and maximum time than the mixed-time approach. In general, up to 65% of the influences are transmitted within just 20 weeks of the initial shock, while the rest of the influences (i.e., up to at least 95% of the total influences) require up to 560 weeks.

Figure 2.4.2.1: Minimum Time Required for Influences to Travel from Agricultural Crop Sector to Households under Mixed-Time Transformation

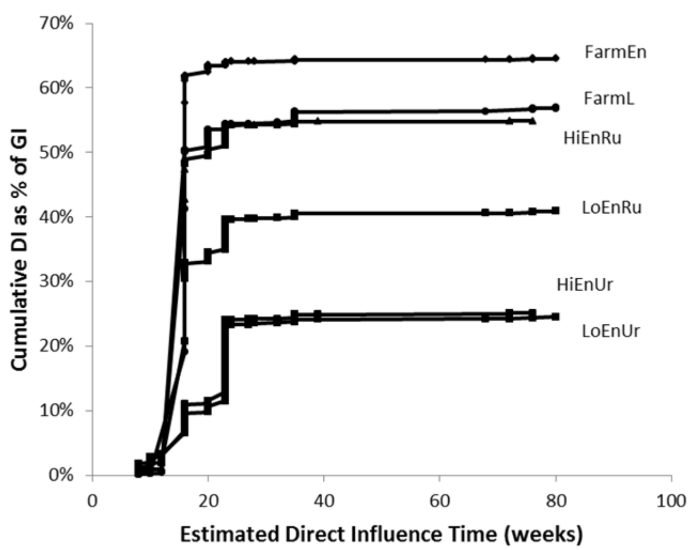


Figure 2.4.2.2: Maximum Time Required for Influences to Travel from Agricultural Crop Sector to Households under Mixed-Time Transformation

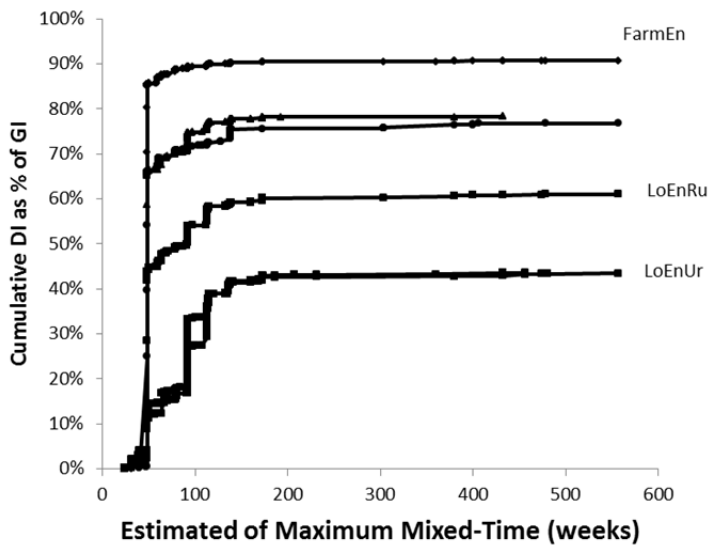


Table 2.4.2.1: Time Required for Influences to Travel from Agricultural Crop Sector to Households under Fixed-Time Transformation

	Mixed time direct			Influence	Mixed time with loops			Influence	Global
Origin - Destination	Min	Average	Max	% Global	Min	Average	Max	% Global	Impact
SAgCrop - FarmL	7.7	28.5	80.0	56.9%	30.8	119.3	556.5	78.2%	0.1183
SAgCrop - FarmEn	7.7	17.1	23.0	63.8%	23.8	71.3	136.4	92.0%	0.6877
SAgCrop - LoEnRu	7.7	17.3	23.0	38.3%	23.8	71.8	136.4	57.9%	0.1836
SAgCrop - HiEnRu	7.7	18.2	23.0	53.6%	23.8	75.9	136.4	78.1%	0.2903
SAgCrop - LoEnUr	7.7	14.3	23.0	16.1%	23.8	61.3	135.5	28.4%	0.1835
SAgCrop - HiEnUr	7.7	14.5	23.0	18.4%	23.8	63.6	136.0	32.0%	0.2573

Table 2.4.2.2: Time Required for Influences to Travel from Agricultural Crop Sector to Households under Mixed-Time Transformation

	Mixed time direct			Influence	Mixed time with loops			Influence	Global
Origin - Destination	Min	Average	Max	% Global	Min	Average	Max	% Global	Impact
SChemMet - FarmL	4.0	22.5	79.8	30.2%	12.0	107.4	478.9	50.1%	0.0434
SChemMet - FarmEn	4.0	9.0	11.9	23.5%	12.0	41.6	65.9	39.6%	0.1922
SChemMet - LoEnRu	4.0	9.4	11.9	36.1%	12.0	38.2	64.0	54.5%	0.1195
SChemMet - HiEnRu	4.0	9.6	11.0	28.5%	12.0	39.3	64.4	43.6%	0.1276
SChemMet - LoEnUr	4.0	9.0	11.0	38.2%	12.0	37.8	64.0	58.2%	0.1870
SChemMet - HiEnUr	4.0	9.0	11.0	30.0%	12.0	36.3	63.5	48.3%	0.2151

Regarding the time value of money, for every 1 rupiah that should be received by households, only a fraction is received due to the loss of its value with regards to the time value of money. Under the mixed-time approach[7] with an annually compounded interest rate of 8.5%, for every dollar of the direct influence that should be received by farm labor households, they only receive 0.877-0.987 rupiah within 8 to 80 weeks from the initial shock. This means that when there is an injection of 1 million rupiah in the agricultural crop sector, we know that the farm labor households will receive a global influence of 118.3 thousand rupiah; however, since we are using 95% of total influence and excluding all paths whose direct influence is less than 0.0001, the cumulative total influence is as much as 87.9 thousand rupiah. Employing the mixed-time approach, at the time when this 87.9 thousand rupiah is received by farm worker households, it only has the present value of 35.2-86.8 thousand rupiah within 8 to 560 weeks from the initial shock. If we consider only direct influence, the present value will be between 77.1 and 86.8 thousand rupiah. In other words, there is a loss of

[7] Mixed-time transformation uses both fixed and flexible time in one specific path.

income between 1.3% and 60.0% of the value that the farm workers should have received.

How can we relate the SPA effects to its time completion using the 95% level of influence thresholds? Table 2.4.2.3 shows the effects transmitted from agricultural crops to (i) farm workers and (ii) farm entrepreneurs. Farm workers receive their income mainly through agricultural factors of production – both rural and urban as well as wage and non-wage labor. With path multipliers around 1.3, around four passes through the loops are needed in order to reach at least 95% of their total influence. Direct influences from the agricultural sector through agricultural factors require 16 weeks, whereas 95% of the total influences require around 48 weeks to accomplish.

Table 2.4.2.3: SPA Results with Mixed-Time Direct and Maximum Mixed-Time from Agricultural Sector to Households

Paths	Direct Effect	Path Multiplier	Total Effect	Direct Time	Max Time
SAgCrop - AgWRu - FarmL	0.0223	1.3353	0.0297	16.0	48.0
SAgCrop - AgWUr - FarmL	0.0135	1.3125	0.0177	16.0	48.0
SAgCrop - AgNWRu - FarmL	0.0128	1.3582	0.0174	16.0	48.0
SAgCrop - AgNWUr - FarmL	0.0104	1.3136	0.0137	16.0	48.0
SAgCrop - DCAgLivSt - SAgLivSt - AgWRu - FarmL	0.0007	1.4673	0.0010	19.8	59.5

a. Agricultural Sector to Farm Labor

Paths	Direct Effect	Path Multiplier	Total Effect	Direct Time	Max Time
SAgCrop - AgNWRu - FarmEn	0.3451	1.4300	0.4935	16.0	48.0
SAgCrop - AgWRu - FarmEn	0.0496	1.4303	0.0709	16.0	48.0
SAgCrop - AgNWUr - FarmEn	0.0232	1.4143	0.0328	16.0	48.0
SAgCrop - DCAgLivSt - SAgLivSt - AgNWRu - FarmEn	0.0042	1.5539	0.0066	19.8	59.5
SAgCrop - DCAgFish - SAgFish - AgNWRu - FarmEn	0.0026	1.7610	0.0045	19.5	78.0

b. Agricultural Sector to Farm Entrepreneur

The influences from the agricultural sector are higher on farm entrepreneurs than on farm workers. In almost all paths, any increase in production from agricultural sectors would benefits the farm entrepreneurs more than it benefits farm labor. This is in line with D'Silva and Bysouth (1992, p. 16), who argued that policies to boost agricultural production may increase income inequality. These total influences will reach their destinations (i.e., either farm workers or farm entrepreneurs) within 16 to 48 weeks.

2.4.3. Transmission of Influence from Chemical and Metallic Sector to Farm Workers

In this section, we examine the transmission of influences from the chemical and metallic sector to farm workers. It was found that the paths with direct influences greater than 0.0001 from the chemical and metallic sector (SChemMet) to farm workers (FarmL) account for 27% of the global influence, while the total of influences greater than 0.0001 accounts for 46% of its global influence. The shortest significant routes take around 4 weeks to reach the farm workers. All of these significant short routes have a direct influence and total influence of around 11% and 16% of the global influence, respectively. Figure 2.4.3.1 shows the routes, time and SAM marginal expenditure between poles. In addition to the abbreviations in Figure 2.4.1.1, several additional abbreviations are used in Figure 2.4.3.1: *PrWRu* for production workers in rural areas as receivers of wages, *PrWUr* for production workers in urban areas as receivers of wages, *PrNWRu* for production workers in rural areas as non-receivers of wages, *PrNWUr* for production workers in urban areas as non-receivers of wages, and

MgNWRu for management workers in rural areas non-receivers of wages. The complete list can be seen in List of Abbreviations (Appendix 2.A).

Figure 2.4.3.1: Paths from Chemical and Metallic Sector to Farm Workers

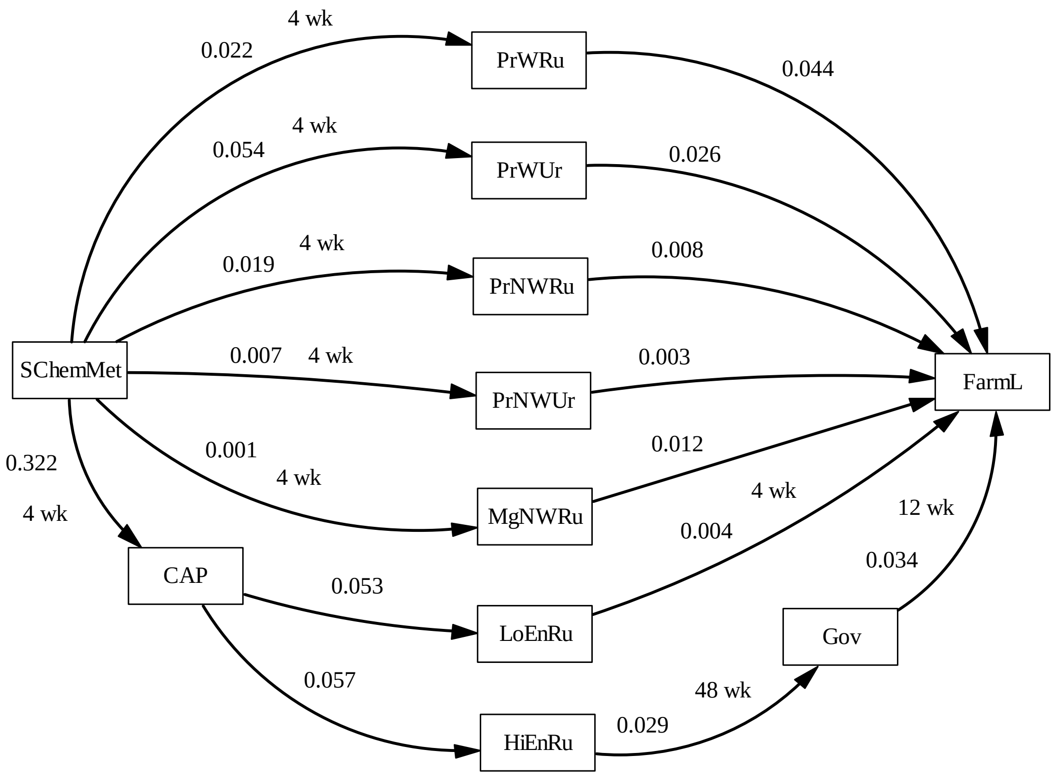


Table 2.4.3.1: SPA and Time Related to Transmission of Influences from Chemical and Metallic Sector to Farm Workers

	Effects			Direct Time		Max Time		%tage
Paths	Direct	Total	Path mult	Fixed	Mixed	Fixed	Mixed	of Global
SChemMet - PrWRu - FarmL	0.00098	0.00130	1.3249	4.00	4.00	12.00	12.00	3.0%
SChemMet - PrWUr - FarmL	0.00141	0.00194	1.3744	4.00	4.00	12.00	12.00	4.5%
SChemMet - PrNWRu - FarmL	0.00015	0.00019	1.3167	4.00	4.00	12.00	12.00	0.4%
SChemMet - PrNWUr - FarmL	0.00002	0.00003	1.3229	4.00	4.00	12.00	12.00	0.1%
SChemMet - MgNWRu - FarmL	0.00001	0.00002	1.2919	4.00	4.00	12.00	12.00	0.0%
SChemMet - CAP - LoEnUr - FarmL	0.00007	0.00013	1.6726	8.00	8.00	32.00	32.00	0.3%
SChemMet - CAP - HiEnRu - Gov - FarmL	0.00002	0.00004	1.9721	64.00	64.00	320.00	320.00	0.1%
Global Multiplier	0.0434							

The time required to transmit the influences ranges from 4 to 320 weeks based on Table 2.4.3.1; however, if we look at even smaller total influences in other paths, the time required to transmit increases to around 480 weeks. The detailed results can be found in Appendix 2B.

If we only consider direct influences, farm labor receives more than 20% of the global influence within just about 20 weeks of the initial shock with the remaining 7% spread out across the next 60 weeks. By around 90 weeks from the initial shock, the sum of all total influences reaches around 30% of the global influence, while the remaining 16% is spread out over the next 390 weeks. The development of influences and the required-time can be seen in Figure 2.4.3.2.[8] A summary of required-time based on fixed- and mixed-time transformations can be seen in Table 2.4.3.2, which is based on direct paths that are bigger than 0.00001. In Table 2.4.3.2, the range of time required under fixed- and mixed-time transformation are relatively not different. The direct influence takes between 4 and 80 weeks while the 95% of the total influence takes between 12 and around 480 weeks. Figure 2.4.3.2 summarizes all of the required-time (fixed- and flexible-time) of the direct influences for the paths from chemical and metallic sector to farm workers sorted from the shortest to the longest time. Several paths have the same length of time for their direct influences, and create what looks like the vertical line in the graph. The same is true with the mixed-time with loops which represents all of the times required (fixed- and flexible-time) to reach at least 95% of the total influences sorted from the shortest to the longest time. Several paths require the same length of time, which creates what looks like the

[8] In Figure 2.4.4.2, for the sake of clarity, data beyond 400 weeks are not presented.

vertical segment of the graph. In this case, we can think of the mixed-time direct as the shortest time required by the influences to travel from chemical and metallic sectors to the farm workers, whereas the mixed-time with loops can be thought of as the longest time required for 95% of the total influences to travel from chemical and metallic sector to the farm workers.

Figure 2.4.3.2: Required Time for Direct and Total Influences to Travel from Chemical and Metallic Sector to Farm Workers

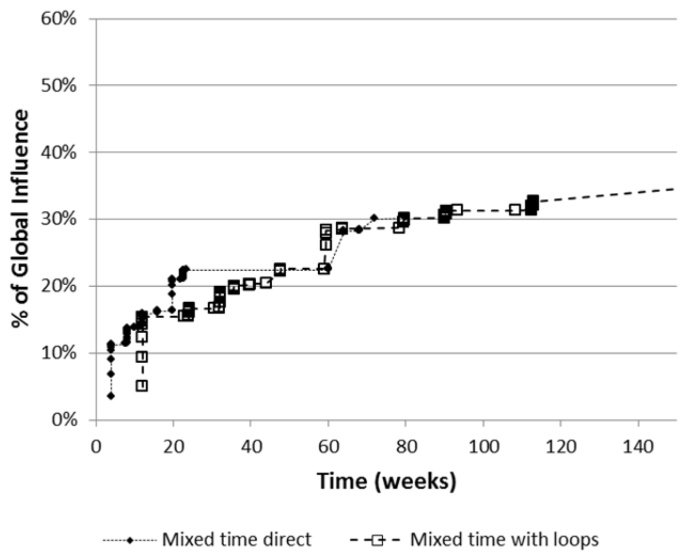


Table 2.4.3.2: Time Summary of Chemical and Metallic Sector to Farm Workers

Total of significant direct paths (> 0.00001)	Time (weeks) min	average	max	Impact % Global
Fixed time (w/o loops)	4.0	22.7	80.0	30.2%
Fixed time (incl. loops)	12.0	108.4	480.0	50.1%
Mixed time (w/o loops)	4.0	22.5	79.8	30.2%
Mixed time (incl. loops)	12.0	107.4	478.9	50.1%

2.4.4. Transmission of Influence from Chemical and Metallic Sector to Various Households

Figure 2.4.4.1 shows the times required for the initial direct influence to be transmitted from the chemical and metallic sector (SChemMet) to different household groups. As expected, farm labor is the household group that receives the lowest direct influences of only around 22% of the global influences within just 30 weeks of the initial shock. Surprisingly, farm entrepreneurs follow directly behind the farm labor group as the second-lowest receiver of direct influence, which reaches only about 33% of the global influence within 30 weeks of the initial shock. In general, all household groups (with the exception of farm labor) receive most of their direct influences within 30 weeks of the initial shock. Beginning around 60 weeks from the initial shock, all other household groups have relatively small increase of the cumulative transmitted influences, while only the farm labor group has a sudden increase to 30% of the global influence. The receiver of the highest influences (about 43%) is the low-urban entrepreneur group.

When we include the loops required to reach up to 95% of the total influence, the results are not much different. As expected, all of the urban entrepreneurs who essentially use a lot of these chemical and metallic products require between around 60 to 80 weeks to receive 50-70% of the global influences (Fig. 2.4.4.2). Though the farm labor group receives the lowest transmitted influence, it continues to receive more influences to reach up to almost 45% of the global influence within 350 weeks after the initial influence. In general, 95% of total influences are achieved within around 450 weeks.[9]

In contrast, all of the urban entrepreneur households which are expected to receive the highest total influence are also identified as those that have the shortest required time to achieve the 95% of the total influences. While all urban households require only about 80 months to receive 95% of the total influences, farm households require about 150-450 weeks.

Considering the required time for transmitting the influences, Tables 2.4.4.1 and 2.4.4.2 show the results under fixed- and mixed-time transformation, respectively. Again, we observe that the fixed-time approach, as expected, shows slightly higher minimum, average and maximum times than the mixed-time approach. In general, nearly 70% of the global influences are transmitted within 50 weeks of the initial shock, and the remaining 25% of the influences require up to almost 500 weeks from the initial shocks.

[9] In Figure 2.4.4.2, for the sake of clarity, data beyond 400 weeks are not presented.

Figure 2.4.4.1: Minimum Time Required for Influences to Travel from Chemical and Metallic Sector to Households under Mixed-Time Transformation

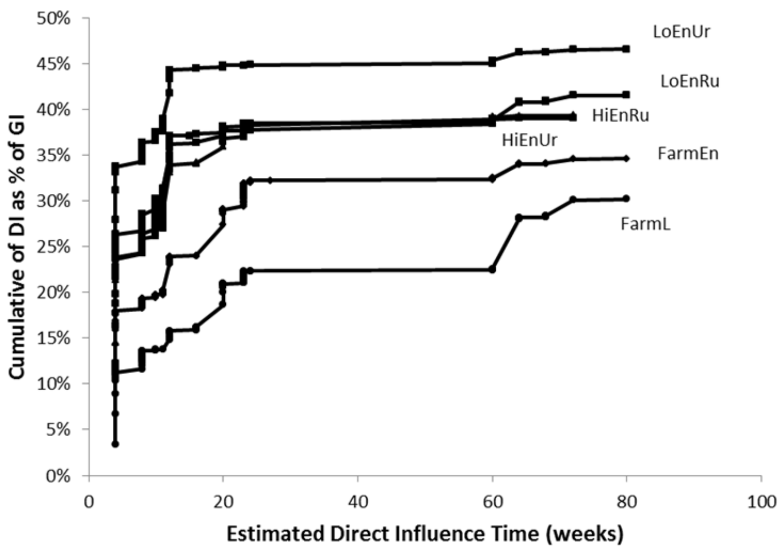


Figure 2.4.4.2: Maximum Time Required for Influences to Travel from Chemical and Metallic Sector to Households under Mixed-Time Transformation

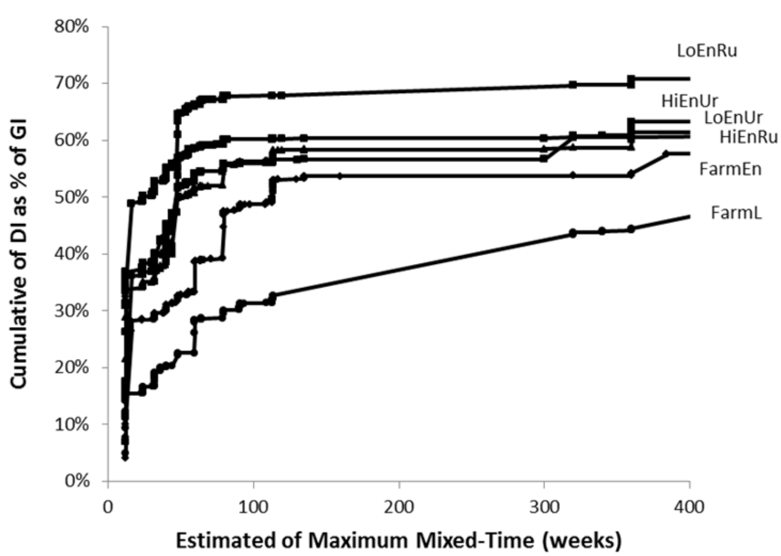


Table 2.4.4.1: Time Required for Influences to Travel from Chemical and Metallic Sector to Households under Fixed-Time Transformation

	Fixed time direct			Influence	Fixed time with loops			Influence	Global
Origin - Destination	Min	Average	Max	% Global	Min	Average	Max	% Global	Impact
SChemMet - FarmL	4.0	22.7	80.0	30.2%	12.0	108.4	480.0	50.1%	0.0434
SChemMet - FarmEn	4.0	9.1	12.0	23.5%	12.0	42.2	66.0	39.6%	0.1922
SChemMet - LoEnRu	4.0	9.5	12.0	36.1%	12.0	38.8	66.0	54.5%	0.1195
SChemMet - HiEnRu	4.0	9.7	11.0	28.5%	12.0	39.8	66.0	43.6%	0.1276
SChemMet - LoEnUr	4.0	9.1	11.0	38.2%	12.0	38.4	66.0	58.2%	0.1870
SChemMet - HiEnUr	4.0	9.1	11.0	30.0%	12.0	36.7	66.0	48.3%	0.2151

Table 2.4.4.2: Time Required for Influences to Travel from Chemical and Metallic Sector to Households under Mixed-Time Transformation

	Mixed time direct			Influence	Mixed time with loops			Influence	Global
Origin - Destination	Min	Average	Max	% Global	Min	Average	Max	% Global	Impact
SChemMet - FarmL	4.0	22.5	79.8	30.2%	12.0	107.4	478.9	50.1%	0.0434
SChemMet - FarmEn	4.0	9.0	11.9	23.5%	12.0	41.6	65.9	39.6%	0.1922
SChemMet - LoEnRu	4.0	9.4	11.9	36.1%	12.0	38.2	64.0	54.5%	0.1195
SChemMet - HiEnRu	4.0	9.6	11.0	28.5%	12.0	39.3	64.4	43.6%	0.1276
SChemMet - LoEnUr	4.0	9.0	11.0	38.2%	12.0	37.8	64.0	58.2%	0.1870
SChemMet - HiEnUr	4.0	9.0	11.0	30.0%	12.0	36.3	63.5	48.3%	0.2151

Considering the time value of money, for every 1 rupiah that should be received by households, only a fraction is received due to the time loss during the transmission to the households. Let us examine one example from the fourth row of Table 2.4.4.2. Using 95% of the total influence, and excluding all paths with direct influence of less than 0.0001, we find that the cumulative total influence is as much as 58.2% of the global influence of that specific origin and destination poles. This means that for every 1 million rupiah, the low-urban entrepreneur household receives the 95% of the total influence, which is 103.4 thousand rupiah. With an annual compound interest rate of 8.5%, and under the mixed-time approach, the present values of 103.4 thousand rupiah are between 79.1 and 87.3 thousand rupiah within 4 to 64 weeks from the initial shock. This means that for every dollar received by low-urban entrepreneurs, it is only worth 0.983 to 0.990 rupiah in present time.

On the other side, by the same reasoning, for every 1 million rupiah injected into the chemical and metallic sector, the global influence on farm households is 43.4 thousand rupiah. When we exclude all of the paths that have a direct influence of less than 0.0001 and compute the loops up to 95% of the total influence, we find that farm worker households would receive the cumulative 95% total influence of as much as 20.7 thousand rupiah. This has the present value of between 9.4 and 20.5 thousand rupiah within 4 to 479 weeks.

How about the size of influence and time related to the paths from chemical and metallic sector to farm labor or farm entrepreneurs? Tables 2.4.4.3a and 2.4.4.3b explain this more clearly. We can observe that the influence goes from chemical and metallic sector through other sectors before reaching the farm labor. For example, from chemical and metallic sector to farm workers (Table 2.4.4.3a), the path with the highest multiplier is through capital, entrepreneurs, and government which has path multiplier of 2.1 and thus is expected to reach the farm labor between 66 to 330 weeks from the time of its original shock. On the other hand, we have influences that can reach farm labor within just 6 weeks of its original influence. In Table 4.4.3a, two paths have this short time period – namely, the chemical and metallic sector that goes through the pole of capital (CAP), and the pole of production wage in the urban area workers (PrWUr) at the second and third row. The results are interesting because it is clear that the length of the path represents neither the size of the influences nor the length of time to deliver the influences. This is evidence that the biggest path multiplier is neither the one with the longest path nor the one with the longest time required.

A comparison between the two different recipients – farm workers and farm entrepreneurs – reveals that any increase in the output of the domestic commodity of chemical and metallic products will increase the income of farm entrepreneurs more than farm workers (see Table 2.4.4.3b). In terms of the time required to deliver the influences, the farm entrepreneurs receive the influences much faster than farm laborers.

Table 2.4.4.3: SPA Results with Mixed-Time Direct and Maximum Mixed-Time from Chemical and Metallic Sector to Households

Paths	Direct Effect	Path Multiplier	Total Effect	Direct Time	Max Time
SChemMet - CAP - Ent - Gov - FarmL	0.0024	2.0397	0.0048	64.0	320.0
SChemMet - CAP - FarmL	0.0015	1.5178	0.0023	4.0	12.0
SChemMet - PrWUr - FarmL	0.0014	1.3744	0.0019	4.0	12.0
SChemMet - DCForest - SForest - CAP - Ent - Gov - FarmL	0.0008	2.2735	0.0017	71.9	431.5
SChemMet - DCAgLivSt - SAgLivSt - AgWRu - FarmL	0.0011	1.4660	0.0016	19.8	59.5

a. Chemical and Metallic Sector to Farm Labor

Paths	Direct Effect	Path Multiplier	Total Effect	Direct Time	Max Time
SChemMet - CAP - FarmEn	0.0173	1.7038	0.0294	4.0	16.0
SChemMet - DCAgLivSt - SAgLivSt - AgNWRu - FarmEn	0.0064	1.6933	0.0109	19.8	79.3
SChemMet - DCForest - SForest - CAP - FarmEn	0.0055	1.8986	0.0104	11.9	59.5
SChemMet - PrNWRu - FarmEn	0.0055	1.5182	0.0083	4.0	12.0
SChemMet - PrWUr - FarmEn	0.0047	1.5801	0.0074	4.0	12.0

b. Chemical and Metallic Sector to Farm Entrepreneur

2.5. Discussion and Conclusion

Several important results from our exercises are worth emphasizing. First, our case studies showed that the influence reduced dramatically once the first pass had occurred. Generally, after just a pass with one to three loops, more than 95% of the total influences had been transmitted. Based on that, we argue that when SAM assumptions can be held for some period of time, it is actually possible to compute the time required for one specific influence to be transmitted from one sector to another. Here, of course, we adopted the assumptions of excess supply, a demand-driven model and fixed-price assumptions in addition to the implicit fixed structure of the economy without substitution effects. The arguments as to whether these assumptions can be held for a period of time may still be debatable, but as we have shown, the time required to transmit the influences can be estimated by using two approaches: fixed-time transformation and flexible-time transformation.

Second, it should be noted that, when including time in the SPA, within the context of all paths available from a pole of origin to a pole of destination, the shortest time path is not necessarily the shortest path; likewise, the longest time path is not necessarily the longest path. In the past, it has generally been believed that between the pole of origin and the pole of destination, the longer the paths, the longer the time required for the influence to reach its destination. Our results show, however, that this is not correct. The second and third highest total influences from the chemical and metallic sectors reached farm labor through relatively short paths that also had relatively short time periods. When the total influences decreased, the time required did not consistently follow the length of the paths. As it turned out, one of two crucial paths might contribute to the length of time required for one influence to travel to its destination.

This result regarding the required time to transmit the influences should not be confused with the length of the path associated within one specific path. Thus, it should be noted that within one specific path, the longer (shorter) the path becomes as more arcs are added to (taken out of) the path, the longer (shorter) time is required to transmit the influence. Our result surely does not refute this fact but shows that within all of the paths available from one specific pole to another, the shorter path does not necessarily take a shorter time and the longer path does not necessarily take a longer time.

Third, it is important to note that issue of whether one specific path will be a long time path or a short time path depends on the characteristics of the activities embedded in the arcs and the structure of that path. When one specific path contains an activity with a fixed-time transformation and embedded loop structures, then that path is a strong candidate for a long-time path. On the other hand, when a specific path contains no loops and none of the arcs represent an activity with a fixed-time transformation but only flexible-time transformations, then that path is a strong candidate for a short-time path. In addition, some types of activities inherently lengthen the amount of time required to transmit the influences, and some of these activities are related to government activities such as tax returns and subsidies.

When the direct influence is lower than the total influence, we can only conclude that more loops will be required for that specific influence to come close to the level of its total influence, however, the exact time required for transmission of the influence cannot generally be estimated. This is simply because not only there are several paths which take longer to transmit the influence than the others, but also the influences arrive in continuous time from many different paths that connect the origin to the destination sector. In addition, we were also able to show that more complicated poles and adjacent circuits do not necessarily make the transmission time of the influence significantly longer as the crucial paths that inherently require long periods of time do not exist in those adjacent circuits. With this in mind, we can focus more on where the transmission of influence might possibly be disturbed and what can be done to fix those specific paths.

In all cases, we found that the overall influences are transmitted over a period of more than a year mainly due to existing loops caused by government institutions. Any subsidies coming from the government based on taxes paid were generally designed to be released on a quarterly or yearly basis, depending on the type of activities. Therefore, any influences from the government to the households take a long time to be received. From the two categories of sectors – agricultural and non-agricultural – the results indicated that the farm labor group received the influences in the longest time periods. Some of the influences that came from taxes and subsidies took many periods to accomplish. Even though this long transmission period might influence the transmission of influences to agricultural households, the size of these influences after some length of time were not big enough to substantially reduce the households' income.

The SAM 2008 shows how the poor group, which was represented by farm labor, received less than the non-poor group, which was represented by the farm entrepreneurs. The two case studies in this paper reveal that influences coming from any shocks in the agricultural or chemical and metallic sectors take less time to reach farm entrepreneurs than farm labor, and are larger in size. This finding is in line with the biggest five total influences on farm labor and farm entrepreneurs, which showed that livestock sectors and commodities were also affected and served as important channels for transmitting the influence to both households.

In the first case regarding agriculture, the influence toward the higher-income group is larger than that to the lower-income group. In a tendency toward a more globalized world, as discussed by Nissanke and Thorbecke (2006), the differences may not be diminished but rather amplified due to good relative prices, factor mobility, technological advances and diffusion, and institutions among other factors. Without any actions to strengthen and improve the channels through which the low-income group may acquire more benefits from economic growth, the poor households would be most likely to receive much less benefits in any economic growth. In addition, Thorbecke and Jung (1996) pointed out the need to improve the skills and education of the low-income group so that they can receive more benefits from economic development. With respect to time, these efforts should be designed as much possible on a continual basis rather than periodically. The slow action of the government toward the low-income group and the sporadic nature of its efforts, as opposed to an integrated planned system of support, will only cause the poor to suffer not only through the relatively low level of influences but also the time duration required for any influence to reach them. Of course, in addition to all of the above, sound macroeconomic policy, as shown by Thorbecke (1991) in the case of the

Indonesian economy, public infrastructure investment and policies for low inflation with manageable monetary expansion are needed to provide greater benefit to the poor and to ultimately reduce income inequality while maintaining economic growth.

In the case of chemical and metallic sector, there are many paths through which this sector influence reaches farm labor and farm entrepreneurs. Government can play an important role in guiding the influence toward the farm labor and away the farm entrepreneurs. The relatively long span of time that is required to reach the farm labor was mainly caused by the presence of government in the middle of the path, which alone can delay the influence by 48 months. Compared to the farm entrepreneurs who receive higher influence in much less time, one can argue that any changes in chemical and metallic sector will influence the non-poor more than the poor. It follows that reducing the outputs will influence the higher-income groups more and thus reduce the inequality.

How could we then formulate a policy that could benefit primarily the poor quickly enough to eventually reduce the inequality issue? As suggested in Pyatt and Thorbecke (1976), fiscal instruments and transfers can be used to redistribute income to some lower-income groups in society. While direct money transfers may benefit the lower-income households directly, it will not benefit them in the long run because of the nature of direct transfers that merely increasing consumption without utilizing more factor of production of the poor households. Regarding intangible goods, providing free services, such as education and healthcare, for the lower-income groups may benefit them more in the long run, although that benefit will be indirect. These measures would all surely be more effective if they were exercised on a continual basis rather than sporadically. Clearly from this exercise, the more continual provision of services to these lower-income groups would significantly reduce the time required for transmitting the influence that is embedded in returning the benefits from taxes into some type of transfers to these income groups. Moreover, if this is in the type of productive capital transfer which in turn may increase the income of the poor households, then this type of continual provision will even bring more benefits to the poor households.

Therefore, policymakers could estimate the range of economic influence that could be transmitted and how long it might possibly take. Most of the influences could be realized in just the first pass and the first few loops of the path. Once we realize this possibility, we could then establish a SAM-style matrix estimating the time between the source and destination cells. Though we realize that no exact time could possibly be predicted, we could estimate the averages time required for transmission between the source and destination cells. The time required can be defined as fixed-, flexible-time, or both. Therefore, applying those influences will simply require several passes to reach at least 95% of the influences, and we could estimate the transmission of the influence in terms of the size and time required for the transmission of influences from the source to the destination.

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APPENDIX 2.A

THE INDONESIAN SAM 2008 SECTORS AND ITS ABBREVIATIONS

Note: S: sector, DC: domestic commodities, IC: import commodities

No.	Factors, Sectors, Institutions	Abbreviations
1	Agriculture receiver of wages and salaries rural	AgWRu
2	Agriculture receiver of wages and salaries urban	AgWUr
3	Agriculture not receiver of wages and salaries rural	AgNWRu
4	Agriculture not receiver of wages and salaries urban	AgNWUr
5	Production, Transportation Operator, Manual and laborer receiver of wages and salaries rural	PrWRu
6	Production, Transportation Operator, Manual and laborer receiver of wages and salaries urban	PrWUr
7	Production, Transportation Operator, Manual and laborer not receiver of wages and salaries rural	PrNWRu
8	Production, Transportation Operator, Manual and laborer not receiver of wages and salaries urban	PrNWUr
9	Administration, Sales, Services receiver of wages and salaries rural	AdWRu
10	Administration, Sales, Services receiver of wages and salaries urban	AdWUr
11	Administration, Sales, Services not receiver of wages and salaries rural	AdNWRu
12	Administration, Sales, Services not receiver of wages and salaries urban	AdNWUr
13	Leaderships, Management, Military, Proffesional and technicians receiver of wages and salaries rural	MgWRu
14	Leaderships, Management, Military, Proffesional and technicians receiver of wages and salaries urban	MgWUr
15	Leaderships, Management, Military, Proffesional and technicians not receiver of wages and salaries rural	MgNWRu
16	Leaderships, Management, Military, Proffesional and technicians not receiver of wages and salaries urban	MgNWUr
17	Not Labor Force	CAP
18	Farm workers	FarmL
19	Farm enterpreneurs	FarmEn
20	Low Enterpreneurs rural	LoEnRu
21	Not a labor force and unclear workers classification rural	NLFRu
22	High Enterpreneurs rural	HiEnRu
23	Low Enterpreneurs urban	LoEnUr
24	Not a labor force and unclear workers classification urban	NLFUr
25	High Enterpreneurs urban	HiEnUr
26	Enterprises	Ent
27	Government	Gov
28	S. Agricultural Crops	SAgCrop
29	S. Livestocks and Produce	SAgLivSt
30	S. Fishery	SAgFish
31	S. Food industries, beverages and tobaccos	SAgInd
32	S. Other Crop Agriculture	SAgOth
33	S. Forestry and hunts	SForest
34	S. Coal and Metal Ore Mining, oil and gas mining	SMinOil
35	S. Other mining and quarrying	SMinOth
36	S. Industri pemintalan, tekstil dan kulit	STextLeath
37	S. Industrial wood and wooden industry	SWoodInd
38	S. Paper Industries, printings, transportation from metal and other industries	SPapTran
39	S. Chemical industry, fertilizer, clay products & cement and basic metal industry	SChemMet
40	S. Electricity, gas dan clean water	SElecGas
41	S. Construction	SCon
42	S. Wholesale and retails, transportation services support and warehouse	SWholeRet
43	S. Restaurants	SRet
44	S. Hotels	SHotel
45	S. Ground transportation	SGroundTr
46	S. Water and air transport, communication	SWatAirTr
47	S. Transport Services Support, and Warehouses	STranspSup
48	S. Bank and insurance	SBankIns
49	S. Real estate and business services	SRealEst
50	S. Government and defense, education, heath, other social services, film and entertainments	SGovSos
51	S. Individual services, hoseholds and other services	SIndServ

No.	Factors, Sectors, Institutions	Abbreviations
52	Trade margins	TrdMg
53	Transport margins	TranMg
54	DC Agricultural Crops	DCAgCrop
55	DC Livestocks and Produce	DCAgLivSt
56	DC Fishery	DCAgFish
57	DC Food industries, beverages and tobaccos	DCAgInd
58	DC Other Crop Agriculture	DCAgOth
59	DC Forestry and hunts	DCForest
60	DC Coal and Metal Ore Mining, oil and gas mining	DCMinOil
61	DC Other mining and quarrying	DCMinOth
62	DC Spinning, textile, and leather industry	DCTextLeath
63	DC Industrial wood and wooden industry	DCWoodInd
64	DC Paper Industries, printings, transportation from metal and other industries	DCPapTran
65	DC Chemical industry, fertilizer, clay products & cement and basic metal industry	DCChemMet
66	DC Electricity, gas dan clean water	DCElecGas
67	DC Construction	DCCon
68	DC Wholesale and retails, transportation services support and warehouse	DCWholeRet
69	DC Restaurants	DCRet
70	DC Hotels	DCHotel
71	DC Ground transportation	DCGroundTr
72	DC Water and air transport, communication	DCWatAirTr
73	DC Transport Services Support, and Warehouses	DCTranDCpSup
74	DC Bank and insurance	DCBankIns
75	DC Real estate and business services	DCRealEst
76	DC Government and defense, education, heath, other social services, film and entertainments	DCGovSos
77	DC Individual services, hoseholds and other services	DCIndServ
78	IC Agricultural Crops	ICAgCrop
79	IC Livestocks and Produce	ICAgLivSt
80	IC Fishery	ICAgFish
81	IC Food industries, beverages and tobaccos	ICAgInd
82	IC Other Crop Agriculture	ICAgOth
83	IC Forestry and hunts	ICForest
84	IC Coal and Metal Ore Mining, oil and gas mining	ICMinOil
85	IC Other mining and quarrying	ICMinOth
86	IC Industri pemintalan, tekstil dan kulit	ICTextLeath
87	IC Industrial wood and wooden industry	ICWoodInd
88	IC Paper Industries, printings, transportation from metal and other industries	ICPapTran
89	IC Chemical industry, fertilizer, clay products & cement and basic metal industry	ICChemMet
90	IC Restaurants	ICRet
91	IC Hotels	ICHotel
92	IC Ground transportation	ICGroundTr
93	IC Water and air transport, communication	ICWatAirTr
94	IC Transport Services Support, and Warehouses	ICTranICpSup
95	IC Bank and insurance	ICBankIns
96	IC Real estate and business services	ICRealEst
97	IC Government and defense, education, heath, other social services, film and entertainments	ICGovSos
98	IC Individual services, hoseholds and other services	ICIndServ
99	Capital	CapAct
100	Indirect Taxes	IndTax
101	Subsidy	Subs
102	External	Ext

APPENDIX 2.B

RESULTS OF SPA WITH TIME

Agricultural Crop Sector (SAgCrop) – Farm Labor (FarmL)

	Global	0.1182856			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	28 - 1 - 18	0.02225	1.33532	0.02971	16.0	-	16.0	48.0	-	48.0	2.0	1.31418	0.02924	18.81%	18.81%	24.72%	24.72%
2	28 - 2 - 18	0.01345	1.31255	0.01766	16.0	-	16.0	48.0	-	48.0	2.0	1.29483	0.01742	11.37%	30.19%	14.73%	39.45%
3	28 - 3 - 18	0.01284	1.35816	0.01743	16.0	-	16.0	48.0	-	48.0	2.0	1.33325	0.01711	10.85%	41.04%	14.47%	53.92%
4	28 - 4 - 18	0.01044	1.31357	0.01371	16.0	-	16.0	48.0	-	48.0	2.0	1.29570	0.01353	8.82%	49.86%	11.43%	65.35%
5	28 - 5 - 18	0.00002	1.34878	0.00002	16.0	-	16.0	48.0	-	48.0	2.0	1.32546	0.00002	0.02%	49.88%	0.02%	65.37%
6	28 - 7 - 18	0.00001	1.33910	0.00002	16.0	-	16.0	48.0	-	48.0	2.0	1.31735	0.00002	0.01%	49.89%	0.02%	65.39%
7	28 - 11 - 18	0.00001	1.36164	0.00001	16.0	-	16.0	48.0	-	48.0	2.0	1.33613	0.00001	0.01%	49.90%	0.01%	65.40%
8	28 - 15 - 18	0.00002	1.31123	0.00003	16.0	-	16.0	48.0	-	48.0	2.0	1.29369	0.00003	0.02%	49.92%	0.02%	65.43%
9	28 - 17 - 18	0.00021	1.56957	0.00033	16.0	-	16.0	48.0	-	48.0	2.0	1.49456	0.00031	0.18%	50.09%	0.26%	65.69%
10	28 - 1 - 19 - 18	0.00008	1.46753	0.00012	20.0	-	20.0	60.0	-	60.0	2.0	1.42008	0.00011	0.07%	50.16%	0.10%	65.78%
11	28 - 1 - 20 - 18	0.00003	1.45656	0.00004	20.0	-	20.0	60.0	-	60.0	2.0	1.41170	0.00004	0.03%	50.19%	0.04%	65.82%
12	28 - 1 - 22 - 18	0.00003	1.44233	0.00005	20.0	-	20.0	60.0	-	60.0	2.0	1.40073	0.00005	0.03%	50.21%	0.04%	65.86%
13	28 - 2 - 25 - 18	0.00004	1.54623	0.00005	20.0	-	20.0	60.0	-	60.0	2.0	1.47806	0.00005	0.03%	50.24%	0.04%	65.90%
...	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
23	28 - 1 - 19 - 27 - 18	0.00003	1.86177	0.00005	32.0	-	32.0	128.0	-	128.0	3.0	1.77631	0.00005	0.02%	51.20%	0.04%	67.29%
24	28 - 1 - 20 - 27 - 18	0.00001	1.84945	0.00002	76.0	-	76.0	304.0	-	304.0	3.0	1.76715	0.00002	0.01%	51.21%	0.02%	67.31%
25	28 - 1 - 22 - 27 - 18	0.00001	1.83775	0.00002	76.0	-	76.0	304.0	-	304.0	3.0	1.75839	0.00002	0.01%	51.23%	0.02%	67.33%
26	28 - 3 - 19 - 27 - 18	0.00019	1.86871	0.00035	32.0	-	32.0	128.0	-	128.0	3.0	1.78144	0.00034	0.16%	51.39%	0.29%	67.61%
27	28 - 3 - 20 - 27 - 18	0.00002	1.88004	0.00004	76.0	-	76.0	304.0	-	304.0	3.0	1.78978	0.00004	0.02%	51.40%	0.03%	67.65%
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46	28 - 3 - 19 - 26 - 27 - 18	0.00004	2.06936	0.00009	80.0	-	80.0	400.0	-	400.0	4.0	1.99310	0.00009	0.04%	54.12%	0.08%	71.98%
47	28 - 3 - 22 - 26 - 27 - 18	0.00002	2.05618	0.00004	80.0	-	80.0	400.0	-	400.0	4.0	1.98265	0.00004	0.02%	54.13%	0.03%	72.01%
48	28 - 1 - 19 - 56 - 30 - 2 - 18	0.00003	1.80139	0.00005	35.0	1.5	34.5	140.0	6.0	138.0	3.0	1.73083	0.00005	0.02%	54.16%	0.04%	72.05%
49	28 - 1 - 19 - 58 - 32 - 2 - 18	0.00005	1.67894	0.00008	35.0	1.5	34.5	140.0	5.9	137.9	3.0	1.63405	0.00008	0.04%	54.20%	0.06%	72.12%
50	28 - 1 - 19 - 76 - 50 - 10 - 18	0.00001	1.73463	0.00002	23.0	2.0	23.0	92.0	7.9	91.9	3.0	1.67883	0.00002	0.01%	54.21%	0.02%	72.13%
...	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
100	28 - 3 - 21 - 56 - 30 - 1 - 18	0.00004	1.73395	0.00006	35.0	1.5	34.5	140.0	6.0	138.0	3.0	1.67829	0.00006	0.03%	56.04%	0.05%	75.27%
101	28 - 3 - 21 - 56 - 30 - 2 - 18	0.00003	1.72177	0.00005	35.0	1.5	34.5	140.0	6.0	138.0	3.0	1.66860	0.00004	0.02%	56.06%	0.04%	75.31%
102	28 - 3 - 21 - 58 - 32 - 1 - 18	0.00002	1.62202	0.00004	35.0	1.5	34.5	140.0	5.9	137.9	3.0	1.58694	0.00004	0.02%	56.08%	0.03%	75.34%
103	28 - 3 - 21 - 58 - 32 - 2 - 18	0.00004	1.60450	0.00007	35.0	1.5	34.5	140.0	5.9	137.9	3.0	1.57217	0.00007	0.04%	56.12%	0.06%	75.40%
104	28 - 3 - 21 - 69 - 43 - 10 - 18	0.00001	1.60228	0.00002	23.0	1.9	22.9	92.0	7.7	91.7	3.0	1.57029	0.00002	0.01%	56.13%	0.02%	75.42%
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136	28 - 3 - 19 - 69 - 43 - 12 - 25 - 18	0.00001	1.78346	0.00002	27.0	1.9	26.9	108.0	7.7	107.7	3.0	1.71704	0.00002	0.01%	56.86%	0.01%	76.76%
137	28 - 3 - 19 - 76 - 50 - 10 - 25 - 18	0.00001	1.88133	0.00002	27.0	2.0	27.0	108.0	7.9	107.9	3.0	1.79072	0.00002	0.01%	56.87%	0.01%	76.78%
138	28 - 3 - 19 - 76 - 50 - 14 - 25 - 18	0.00002	1.83324	0.00004	27.0	2.0	27.0	108.0	7.9	107.9	3.0	1.75500	0.00004	0.02%	56.89%	0.03%	76.81%

Agricultural Crop Sector (SAgCrop) – Farm Entrepreneur (FarmEn)

	Global	0.6876594			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	28 - 1 - 19	0.04955	1.43030	0.07087	16.0	-	16.0	48.0	-	48.0	2.0	1.39135	0.06894	7.21%	7.21%	10.03%	10.03%
2	28 - 2 - 19	0.00130	1.42111	0.00185	16.0	-	16.0	48.0	-	48.0	2.0	1.38413	0.00180	0.19%	7.40%	0.26%	10.29%
3	28 - 3 - 19	0.34508	1.43004	0.49347	16.0	-	16.0	48.0	-	48.0	2.0	1.39115	0.48005	50.18%	57.58%	69.81%	80.10%
4	28 - 4 - 19	0.02322	1.41429	0.03284	16.0	-	16.0	48.0	-	48.0	2.0	1.37874	0.03201	3.38%	60.95%	4.66%	84.75%
5	28 - 5 - 19	0.00006	1.44762	0.00008	16.0	-	16.0	48.0	-	48.0	2.0	1.40482	0.00008	0.01%	60.96%	0.01%	84.76%
6	28 - 6 - 19	0.00002	1.50125	0.00003	16.0	-	16.0	48.0	-	48.0	2.0	1.44537	0.00003	0.00%	60.96%	0.00%	84.77%
7	28 - 7 - 19	0.00053	1.43285	0.00075	16.0	-	16.0	48.0	-	48.0	2.0	1.39335	0.00073	0.08%	61.04%	0.11%	84.87%
8	28 - 9 - 19	0.00002	1.44071	0.00003	16.0	-	16.0	48.0	-	48.0	2.0	1.39947	0.00002	0.00%	61.04%	0.00%	84.88%
9	28 - 11 - 19	0.00015	1.45873	0.00022	16.0	-	16.0	48.0	-	48.0	2.0	1.41336	0.00021	0.02%	61.06%	0.03%	84.91%
10	28 - 13 - 19	0.00002	1.43246	0.00003	16.0	-	16.0	48.0	-	48.0	2.0	1.39304	0.00003	0.00%	61.07%	0.00%	84.91%
11	28 - 14 - 19	0.00002	1.46251	0.00003	16.0	-	16.0	48.0	-	48.0	2.0	1.41625	0.00003	0.00%	61.07%	0.00%	84.92%
12	28 - 15 - 19	0.00031	1.41294	0.00043	16.0	-	16.0	48.0	-	48.0	2.0	1.37767	0.00042	0.04%	61.11%	0.06%	84.98%
13	28 - 16 - 19	0.00001	1.41910	0.00002	16.0	-	16.0	48.0	-	48.0	2.0	1.38255	0.00002	0.00%	61.12%	0.00%	84.98%
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15	28 - 1 - 18 - 19	0.00002	1.46753	0.00003	16.0	-	16.0	48.0	-	48.0	2.0	1.42008	0.00003	0.00%	61.47%	0.00%	85.55%
16	28 - 1 - 20 - 19	0.00002	1.55149	0.00003	20.0	-	20.0	60.0	-	60.0	2.0	1.48181	0.00003	0.00%	61.47%	0.00%	85.55%
17	28 - 1 - 22 - 19	0.00002	1.53744	0.00003	20.0	-	20.0	60.0	-	60.0	2.0	1.47176	0.00003	0.00%	61.47%	0.00%	85.55%
18	28 - 2 - 18 - 19	0.00001	1.45866	0.00002	16.0	-	16.0	48.0	-	48.0	2.0	1.41331	0.00002	0.00%	61.48%	0.00%	85.56%
19	28 - 2 - 25 - 19	0.00002	1.65634	0.00003	20.0	-	20.0	80.0	-	80.0	3.0	1.61550	0.00003	0.00%	61.48%	0.00%	85.56%
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26	28 - 1 - 18 - 27 - 19	0.00002	1.86177	0.00004	28.0	-	28.0	112.0	-	112.0	3.0	1.77631	0.00003	0.00%	61.54%	0.01%	85.65%
27	28 - 1 - 20 - 27 - 19	0.00001	1.96105	0.00003	76.0	-	76.0	380.0	-	380.0	4.0	1.90561	0.00003	0.00%	61.54%	0.00%	85.65%
28	28 - 1 - 22 - 27 - 19	0.00002	1.94952	0.00003	76.0	-	76.0	380.0	-	380.0	4.0	1.89608	0.00003	0.00%	61.54%	0.00%	85.66%
29	28 - 2 - 18 - 27 - 19	0.00001	1.85096	0.00002	28.0	-	28.0	112.0	-	112.0	3.0	1.76827	0.00002	0.00%	61.54%	0.00%	85.66%
30	28 - 3 - 18 - 27 - 19	0.00001	1.86871	0.00002	28.0	-	28.0	112.0	-	112.0	3.0	1.78144	0.00002	0.00%	61.54%	0.00%	85.66%
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67	28 - 3 - 22 - 26 - 27 - 19	0.00002	2.14722	0.00005	80.0	-	80.0	400.0	-	400.0	4.0	2.05374	0.00005	0.00%	63.40%	0.01%	88.68%
68	28 - 65 - 39 - 17 - 26 - 19	0.00002	2.18754	0.00005	12.0	1.7	11.7	60.0	8.5	58.5	4.0	2.08440	0.00004	0.00%	63.40%	0.01%	88.69%
69	28 - 1 - 18 - 55 - 29 - 3 - 19	0.00002	1.60424	0.00003	35.0	1.8	34.8	140.0	7.3	139.3	3.0	1.57195	0.00003	0.00%	63.40%	0.00%	88.69%
70	28 - 1 - 18 - 56 - 30 - 3 - 19	0.00010	1.81032	0.00019	35.0	1.5	34.5	140.0	6.0	138.0	3.0	1.73765	0.00018	0.02%	63.42%	0.03%	88.72%
71	28 - 1 - 18 - 58 - 32 - 3 - 19	0.00004	1.69307	0.00007	35.0	1.5	34.5	140.0	5.9	137.9	3.0	1.64552	0.00007	0.01%	63.42%	0.01%	88.73%
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315	65 - 53 - 71 - 45 - 77 - 51 - 14 - 19	0.00001	1.73467	0.00002	12.0	4.3	10.3	48.0	17.1	41.1	3.0	1.67886	0.00002	0.01%	64.56%	0.01%	90.81%
316	65 - 53 - 71 - 45 - 77 - 51 - 17 - 19	0.00005	1.87616	0.00009	12.0	4.3	10.3	48.0	17.1	41.1	3.0	1.78693	0.00008	0.02%	64.58%	0.04%	90.86%
317	65 - 53 - 72 - 46 - 17 - 26 - 27 - 19	0.00003	2.55782	0.00008	68.0	1.9	67.9	476.0	13.6	475.6	6.0	2.47831	0.00008	0.02%	64.59%	0.04%	90.90%

Agricultural Crop Sector (SAgCrop) – Low Entrepreneur in Rural area (LoEnRu)

	Global	0.1835879			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	28 - 1 - 20	0.01771	1.41930	0.02514	16.0	-	16.0	48.0	-	48.0	2.0	1.38270	0.02449	9.65%	9.65%	13.34%	13.34%
2	28 - 3 - 20	0.03446	1.43847	0.04957	16.0	-	16.0	48.0	-	48.0	2.0	1.39773	0.04817	18.77%	28.42%	26.24%	39.58%
3	28 - 5 - 20	0.00027	1.40453	0.00038	16.0	-	16.0	48.0	-	48.0	2.0	1.37097	0.00037	0.15%	28.57%	0.20%	39.78%
4	28 - 7 - 20	0.00026	1.41695	0.00037	16.0	-	16.0	48.0	-	48.0	2.0	1.38085	0.00037	0.14%	28.71%	0.20%	39.98%
5	28 - 9 - 20	0.00011	1.41113	0.00015	16.0	-	16.0	48.0	-	48.0	2.0	1.37623	0.00015	0.06%	28.77%	0.08%	40.06%
6	28 - 11 - 20	0.00081	1.41333	0.00114	16.0	-	16.0	48.0	-	48.0	2.0	1.37798	0.00112	0.44%	29.21%	0.61%	40.67%
7	28 - 13 - 20	0.00002	1.41195	0.00003	16.0	-	16.0	48.0	-	48.0	2.0	1.37688	0.00003	0.01%	29.22%	0.02%	40.69%
8	28 - 15 - 20	0.00093	1.39213	0.00129	16.0	-	16.0	48.0	-	48.0	2.0	1.36102	0.00126	0.51%	29.73%	0.69%	41.37%
9	28 - 17 - 20	0.00166	1.62887	0.00271	16.0	-	16.0	64.0	-	64.0	3.0	1.59268	0.00265	0.90%	30.63%	1.44%	42.82%
10	28 - 1 - 18 - 20	0.00002	1.45656	0.00003	16.0	-	16.0	48.0	-	48.0	2.0	1.41170	0.00003	0.01%	30.64%	0.01%	42.83%
11	28 - 1 - 19 - 20	0.00004	1.55149	0.00006	20.0	-	20.0	60.0	-	60.0	2.0	1.48181	0.00006	0.02%	30.67%	0.03%	42.86%
12	28 - 1 - 22 - 20	0.00002	1.52623	0.00004	20.0	-	20.0	60.0	-	60.0	2.0	1.46367	0.00003	0.01%	30.68%	0.02%	42.88%
13	28 - 2 - 18 - 20	0.00001	1.43968	0.00002	16.0	-	16.0	48.0	-	48.0	2.0	1.39867	0.00001	0.01%	30.69%	0.01%	42.89%
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22	28 - 1 - 18 - 27 - 20	0.00002	1.84945	0.00003	28.0	-	28.0	112.0	-	112.0	3.0	1.76715	0.00003	0.01%	31.06%	0.02%	43.47%
23	28 - 1 - 19 - 27 - 20	0.00003	1.96105	0.00005	32.0	-	32.0	160.0	-	160.0	4.0	1.90561	0.00005	0.01%	31.08%	0.03%	43.49%
24	28 - 1 - 22 - 27 - 20	0.00001	1.93691	0.00003	76.0	-	76.0	380.0	-	380.0	4.0	1.88562	0.00002	0.01%	31.09%	0.01%	43.51%
25	28 - 3 - 19 - 27 - 20	0.00019	1.96340	0.00037	32.0	-	32.0	160.0	-	160.0	4.0	1.90755	0.00036	0.10%	31.19%	0.20%	43.70%
26	28 - 3 - 21 - 27 - 20	0.00003	1.87316	0.00005	76.0	-	76.0	304.0	-	304.0	3.0	1.78472	0.00005	0.02%	31.20%	0.03%	43.73%
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59	28 - 3 - 19 - 26 - 27 - 20	0.00004	2.17306	0.00010	80.0	-	80.0	400.0	-	400.0	4.0	2.07345	0.00009	0.02%	33.60%	0.05%	47.78%
60	28 - 3 - 22 - 26 - 27 - 20	0.00002	2.15982	0.00004	80.0	-	80.0	400.0	-	400.0	4.0	2.06337	0.00004	0.01%	33.61%	0.02%	47.80%
61	28 - 65 - 39 - 17 - 26 - 20	0.00001	2.16401	0.00003	12.0	1.7	11.7	60.0	8.5	58.5	4.0	2.06657	0.00003	0.01%	33.62%	0.02%	47.81%
62	28 - 1 - 18 - 56 - 30 - 3 - 20	0.00001	1.82757	0.00002	35.0	1.5	34.5	140.0	6.0	138.0	3.0	1.75073	0.00002	0.01%	33.63%	0.01%	47.82%
63	28 - 1 - 18 - 58 - 32 - 17 - 20	0.00001	1.90237	0.00002	35.0	1.5	34.5	175.0	7.4	172.4	4.0	1.85669	0.00002	0.01%	33.63%	0.01%	47.84%
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200	28 - 3 - 21 - 76 - 50 - 15 - 20	0.00001	1.63653	0.00002	23.0	2.0	23.0	92.0	7.9	91.9	3.0	1.59908	0.00002	0.01%	38.11%	0.01%	55.91%
201	28 - 3 - 21 - 76 - 50 - 17 - 20	0.00001	1.83162	0.00002	23.0	2.0	23.0	92.0	7.9	91.9	3.0	1.75378	0.00002	0.01%	38.11%	0.01%	55.92%
202	28 - 3 - 21 - 77 - 51 - 5 - 20	0.00001	1.56325	0.00002	23.0	2.0	23.0	69.0	5.9	68.9	2.0	1.49013	0.00002	0.01%	38.12%	0.01%	55.93%
203	28 - 3 - 22 - 56 - 30 - 1 - 20	0.00007	1.89679	0.00012	35.0	1.5	34.5	140.0	6.0	138.0	3.0	1.80201	0.00012	0.04%	38.16%	0.06%	56.00%
204	28 - 3 - 22 - 56 - 30 - 5 - 20	0.00002	1.89237	0.00003	35.0	1.5	34.5	140.0	6.0	138.0	3.0	1.79879	0.00003	0.01%	38.17%	0.02%	56.01%
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304	28 - 3 - 19 - 76 - 50 - 14 - 25 - 20	0.00002	1.90834	0.00003	27.0	2.0	27.0	135.0	9.9	134.9	4.0	1.86172	0.00003	0.01%	40.88%	0.02%	60.98%
305	28 - 17 - 26 - 27 - 76 - 50 - 9 - 20	0.00002	2.37978	0.00004	72.0	2.0	72.0	432.0	11.9	431.9	5.0	2.28938	0.00004	0.01%	40.89%	0.02%	61.00%
306	28 - 17 - 26 - 27 - 76 - 50 - 13 - 20	0.00001	2.36172	0.00003	72.0	2.0	72.0	432.0	11.9	431.9	5.0	2.27495	0.00003	0.01%	40.90%	0.02%	61.02%

Agricultural Crop Sector (SAgCrop) – High Entrepreneur in Rural area (HiEnRu)

	Global	0.290269			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	28 - 1 - 22	0.01336	1.40534	0.01878	16.0	-	16.0	48.0	-	48.0	2.0	1.37162	0.01833	4.60%	4.60%	6.31%	6.31%
2	28 - 3 - 22	0.12104	1.41561	0.17134	16.0	-	16.0	48.0	-	48.0	2.0	1.37978	0.16701	41.70%	46.30%	57.53%	63.85%
3	28 - 5 - 22	0.00003	1.41386	0.00005	16.0	-	16.0	48.0	-	48.0	2.0	1.37840	0.00005	0.01%	46.31%	0.02%	63.86%
4	28 - 7 - 22	0.00068	1.39461	0.00095	16.0	-	16.0	48.0	-	48.0	2.0	1.36301	0.00092	0.23%	46.55%	0.32%	64.18%
5	28 - 9 - 22	0.00018	1.39006	0.00025	16.0	-	16.0	48.0	-	48.0	2.0	1.35935	0.00024	0.06%	46.61%	0.08%	64.27%
6	28 - 11 - 22	0.00043	1.41301	0.00061	16.0	-	16.0	48.0	-	48.0	2.0	1.37772	0.00060	0.15%	46.76%	0.21%	64.47%
7	28 - 13 - 22	0.00019	1.38310	0.00026	16.0	-	16.0	48.0	-	48.0	2.0	1.35371	0.00026	0.07%	46.82%	0.09%	64.56%
8	28 - 15 - 22	0.00053	1.37671	0.00073	16.0	-	16.0	48.0	-	48.0	2.0	1.34851	0.00072	0.18%	47.01%	0.25%	64.81%
9	28 - 17 - 22	0.00258	1.60741	0.00414	16.0	-	16.0	64.0	-	64.0	3.0	1.57463	0.00406	0.89%	47.89%	1.40%	66.21%
10	28 - 3 - 19 - 22	0.00004	1.53053	0.00006	20.0	-	20.0	60.0	-	60.0	2.0	1.46678	0.00006	0.01%	47.91%	0.02%	66.23%
11	28 - 17 - 26 - 22	0.00012	1.83057	0.00021	20.0	-	20.0	80.0	-	80.0	3.0	1.75299	0.00020	0.04%	47.95%	0.07%	66.30%
12	28 - 3 - 19 - 26 - 22	0.00002	1.82385	0.00003	24.0	-	24.0	96.0	-	96.0	3.0	1.74792	0.00003	0.01%	47.95%	0.01%	66.31%
13	28 - 3 - 19 - 27 - 22	0.00002	1.94106	0.00003	32.0	-	32.0	160.0	-	160.0	4.0	1.88907	0.00003	0.01%	47.96%	0.01%	66.32%
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20	28 - 55 - 29 - 13 - 22	0.00002	1.52573	0.00003	20.0	1.8	19.8	60.0	5.5	59.5	2.0	1.46331	0.00003	0.01%	48.67%	0.01%	67.36%
21	28 - 55 - 29 - 15 - 22	0.00001	1.51885	0.00002	20.0	1.8	19.8	60.0	5.5	59.5	2.0	1.45830	0.00002	0.00%	48.67%	0.01%	67.37%
22	28 - 55 - 29 - 17 - 22	0.00015	1.75968	0.00026	20.0	1.8	19.8	80.0	7.3	79.3	3.0	1.69855	0.00025	0.05%	48.72%	0.09%	67.45%
23	28 - 56 - 30 - 1 - 22	0.00033	1.74345	0.00058	20.0	1.5	19.5	80.0	6.0	78.0	3.0	1.68580	0.00056	0.11%	48.83%	0.19%	67.65%
24	28 - 56 - 30 - 3 - 22	0.00090	1.75074	0.00158	20.0	1.5	19.5	80.0	6.0	78.0	3.0	1.69154	0.00152	0.31%	49.14%	0.52%	68.17%
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44	28 - 77 - 51 - 9 - 22	0.00002	1.47273	0.00003	8.0	2.0	8.0	24.0	5.9	23.9	2.0	1.42402	0.00003	0.01%	49.79%	0.01%	69.29%
45	28 - 77 - 51 - 17 - 22	0.00002	1.67797	0.00003	8.0	2.0	8.0	32.0	7.8	31.8	3.0	1.63325	0.00003	0.01%	49.79%	0.01%	69.30%
46	28 - 65 - 39 - 17 - 26 - 22	0.00003	2.14208	0.00007	12.0	1.7	11.7	60.0	8.5	58.5	4.0	2.04979	0.00007	0.01%	49.81%	0.02%	69.33%
47	28 - 1 - 18 - 56 - 30 - 3 - 22	0.00004	1.80699	0.00007	35.0	1.5	34.5	140.0	6.0	138.0	3.0	1.73511	0.00006	0.01%	49.82%	0.02%	69.35%
48	28 - 1 - 18 - 58 - 32 - 3 - 22	0.00002	1.69099	0.00003	35.0	1.5	34.5	140.0	5.9	137.9	3.0	1.64384	0.00002	0.01%	49.82%	0.01%	69.36%
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282	28 - 89 - 52 - 68 - 42 - 9 - 22	0.00003	1.63950	0.00005	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.60155	0.00005	0.01%	54.72%	0.02%	78.01%
283	28 - 89 - 52 - 68 - 42 - 11 - 22	0.00009	1.63738	0.00015	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.59979	0.00015	0.03%	54.75%	0.05%	78.06%
284	28 - 3 - 19 - 27 - 76 - 50 - 9 - 22	0.00002	2.09882	0.00003	28.0	2.0	28.0	140.0	9.9	139.9	4.0	2.01627	0.00003	0.01%	54.76%	0.01%	78.07%
285	28 - 3 - 19 - 27 - 76 - 50 - 13 - 22	0.00006	2.08723	0.00014	28.0	2.0	28.0	140.0	9.9	139.9	4.0	2.00719	0.00013	0.02%	54.78%	0.04%	78.11%
286	28 - 3 - 19 - 58 - 32 - 17 - 26 - 22	0.00001	2.21331	0.00003	39.0	1.5	38.5	195.0	7.4	192.4	4.0	2.10374	0.00003	0.00%	54.79%	0.01%	78.12%
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289	28 - 17 - 26 - 27 - 76 - 50 - 9 - 22	0.00003	2.33939	0.00006	72.0	2.0	72.0	432.0	11.9	431.9	5.0	2.25699	0.00006	0.01%	54.81%	0.02%	78.17%
290	28 - 17 - 26 - 27 - 76 - 50 - 13 - 22	0.00011	2.32518	0.00026	72.0	2.0	72.0	432.0	11.9	431.9	5.0	2.24550	0.00025	0.04%	54.85%	0.09%	78.26%
291	28 - 65 - 39 - 59 - 33 - 17 - 26 - 22	0.00001	2.38695	0.00003	20.0	3.9	17.9	120.0	23.5	107.5	5.0	2.29508	0.00003	0.00%	54.85%	0.01%	78.27%

Agricultural Crop Sector (SAgCrop) – Low Entrepreneur in Urban area (LoEnUr)

	Global	0.1834517			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	28 - 2 - 23	0.00202	1.47508	0.00298	16.0	-	16.0	48.0	-	48.0	2.0	1.42580	0.00288	1.10%	1.10%	1.57%	1.57%
2	28 - 4 - 23	0.00624	1.47060	0.00917	16.0	-	16.0	48.0	-	48.0	2.0	1.42241	0.00887	3.40%	4.50%	4.84%	6.41%
3	28 - 6 - 23	0.00014	1.49575	0.00021	16.0	-	16.0	48.0	-	48.0	2.0	1.44129	0.00020	0.08%	4.58%	0.11%	6.51%
4	28 - 8 - 23	0.00015	1.47785	0.00022	16.0	-	16.0	48.0	-	48.0	2.0	1.42789	0.00021	0.08%	4.66%	0.11%	6.63%
5	28 - 10 - 23	0.00004	1.56302	0.00006	16.0	-	16.0	48.0	-	48.0	2.0	1.48997	0.00006	0.02%	4.68%	0.03%	6.66%
6	28 - 12 - 23	0.00006	1.52939	0.00009	16.0	-	16.0	48.0	-	48.0	2.0	1.46596	0.00008	0.03%	4.71%	0.05%	6.71%
7	28 - 16 - 23	0.00012	1.47122	0.00017	16.0	-	16.0	48.0	-	48.0	2.0	1.42288	0.00017	0.06%	4.77%	0.09%	6.80%
8	28 - 17 - 23	0.00238	1.69233	0.00402	16.0	-	16.0	64.0	-	64.0	3.0	1.64493	0.00391	1.29%	6.07%	2.13%	8.93%
9	28 - 1 - 18 - 23	0.00002	1.53631	0.00003	16.0	-	16.0	48.0	-	48.0	2.0	1.47095	0.00003	0.01%	6.08%	0.02%	8.94%
10	28 - 1 - 19 - 23	0.00007	1.63172	0.00011	20.0	-	20.0	80.0	-	80.0	3.0	1.59507	0.00011	0.04%	6.11%	0.06%	9.00%
11	28 - 1 - 20 - 23	0.00001	1.62046	0.00002	20.0	-	20.0	80.0	-	80.0	3.0	1.58563	0.00002	0.01%	6.12%	0.01%	9.01%
12	28 - 1 - 22 - 23	0.00002	1.60640	0.00004	20.0	-	20.0	80.0	-	80.0	3.0	1.57378	0.00004	0.01%	6.14%	0.02%	9.03%
13	28 - 2 - 18 - 23	0.00001	1.51229	0.00002	16.0	-	16.0	48.0	-	48.0	2.0	1.45351	0.00002	0.01%	6.14%	0.01%	9.04%
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24	28 - 1 - 18 - 27 - 23	0.00001	1.94541	0.00002	28.0	-	28.0	140.0	-	140.0	4.0	1.89268	0.00002	0.01%	6.70%	0.01%	9.95%
25	28 - 1 - 19 - 27 - 23	0.00002	2.05755	0.00004	32.0	-	32.0	160.0	-	160.0	4.0	1.98374	0.00004	0.01%	6.71%	0.02%	9.97%
26	28 - 3 - 19 - 26 - 23	0.00002	1.93403	0.00004	24.0	-	24.0	120.0	-	120.0	4.0	1.88322	0.00004	0.01%	6.72%	0.02%	9.99%
27	28 - 3 - 19 - 27 - 23	0.00013	2.05698	0.00028	32.0	-	32.0	160.0	-	160.0	4.0	1.98329	0.00027	0.07%	6.79%	0.14%	10.14%
28	28 - 3 - 20 - 27 - 23	0.00002	2.06821	0.00003	76.0	-	76.0	380.0	-	380.0	4.0	1.99220	0.00003	0.01%	6.80%	0.02%	10.15%
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65	28 - 3 - 19 - 26 - 27 - 23	0.00003	2.27410	0.00007	80.0	-	80.0	480.0	-	480.0	5.0	2.20377	0.00007	0.02%	9.26%	0.04%	14.55%
66	28 - 3 - 22 - 26 - 27 - 23	0.00001	2.26082	0.00003	80.0	-	80.0	480.0	-	480.0	5.0	2.19280	0.00003	0.01%	9.27%	0.02%	14.56%
67	28 - 56 - 30 - 17 - 26 - 23	0.00001	2.36877	0.00003	24.0	1.5	23.5	144.0	9.0	141.0	5.0	2.28059	0.00003	0.01%	9.27%	0.01%	14.58%
68	28 - 65 - 39 - 17 - 26 - 23	0.00004	2.23549	0.00009	12.0	1.7	11.7	72.0	10.1	70.1	5.0	2.17179	0.00009	0.02%	9.30%	0.05%	14.63%
69	28 - 1 - 18 - 58 - 32 - 17 - 23	0.00002	1.97938	0.00004	35.0	1.5	34.5	175.0	7.4	172.4	4.0	1.92068	0.00003	0.01%	9.31%	0.02%	14.65%
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534	28 - 89 - 53 - 71 - 45 - 6 - 23	0.00001	1.59017	0.00002	10.0	3.9	9.9	40.0	15.8	39.8	3.0	1.56000	0.00002	0.01%	24.35%	0.01%	43.05%
535	28 - 89 - 53 - 71 - 45 - 8 - 23	0.00001	1.57188	0.00002	10.0	3.9	9.9	30.0	11.8	29.8	2.0	1.49618	0.00002	0.01%	24.35%	0.01%	43.06%
536	28 - 3 - 19 - 27 - 76 - 50 - 6 - 23	0.00001	2.22136	0.00003	28.0	2.0	28.0	168.0	11.9	167.9	5.0	2.15999	0.00003	0.01%	24.36%	0.02%	43.07%
537	28 - 3 - 19 - 27 - 76 - 50 - 10 - 23	0.00003	2.28064	0.00007	28.0	2.0	28.0	168.0	11.9	167.9	5.0	2.20914	0.00006	0.02%	24.38%	0.03%	43.11%
538	28 - 3 - 19 - 58 - 32 - 17 - 26 - 23	0.00002	2.33082	0.00004	39.0	1.5	38.5	234.0	8.9	230.9	5.0	2.25007	0.00004	0.01%	24.39%	0.02%	43.13%
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546	28 - 17 - 26 - 27 - 76 - 50 - 10 - 23	0.00005	2.53607	0.00013	72.0	2.0	72.0	432.0	11.9	431.9	5.0	2.41086	0.00012	0.03%	24.48%	0.07%	43.35%
547	28 - 17 - 26 - 27 - 76 - 50 - 14 - 23	0.00001	2.45707	0.00003	72.0	2.0	72.0	432.0	11.9	431.9	5.0	2.35022	0.00003	0.01%	24.49%	0.02%	43.37%
548	28 - 65 - 39 - 59 - 33 - 17 - 26 - 23	0.00001	2.49015	0.00003	20.0	3.9	17.9	120.0	23.5	107.5	5.0	2.37580	0.00003	0.01%	24.50%	0.02%	43.39%

Agricultural Crop Sector (SAgCrop) – High Entrepreneur in Urban area (HiEnUr)

	Global	0.2572722			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	28 - 2 - 25	0.00550	1.50980	0.00830	16.0	-	16.0	48.0	-	48.0	2.0	1.45168	0.00798	2.14%	2.14%	3.10%	3.10%
2	28 - 4 - 25	0.01006	1.50630	0.01516	16.0	-	16.0	48.0	-	48.0	2.0	1.44910	0.01458	3.91%	6.05%	5.67%	8.77%
3	28 - 6 - 25	0.00002	1.59254	0.00002	16.0	-	16.0	64.0	-	64.0	3.0	1.56202	0.00002	0.01%	6.05%	0.01%	8.78%
4	28 - 8 - 25	0.00009	1.52426	0.00013	16.0	-	16.0	48.0	-	48.0	2.0	1.46224	0.00013	0.03%	6.09%	0.05%	8.83%
5	28 - 10 - 25	0.00007	1.57955	0.00011	16.0	-	16.0	48.0	-	48.0	2.0	1.50153	0.00010	0.03%	6.12%	0.04%	8.87%
6	28 - 12 - 25	0.00026	1.52552	0.00040	16.0	-	16.0	48.0	-	48.0	2.0	1.46315	0.00038	0.10%	6.22%	0.15%	9.02%
7	28 - 14 - 25	0.00012	1.51528	0.00018	16.0	-	16.0	48.0	-	48.0	2.0	1.45569	0.00017	0.05%	6.26%	0.07%	9.09%
8	28 - 16 - 25	0.00039	1.50331	0.00058	16.0	-	16.0	48.0	-	48.0	2.0	1.44689	0.00056	0.15%	6.41%	0.22%	9.30%
9	28 - 17 - 25	0.00349	1.71914	0.00600	16.0	-	16.0	64.0	-	64.0	3.0	1.66650	0.00581	1.36%	7.77%	2.26%	11.56%
10	28 - 3 - 19 - 25	0.00003	1.66763	0.00006	20.0	-	20.0	80.0	-	80.0	3.0	1.62479	0.00006	0.01%	7.78%	0.02%	11.58%
11	28 - 3 - 22 - 25	0.00002	1.65367	0.00003	20.0	-	20.0	80.0	-	80.0	3.0	1.61330	0.00003	0.01%	7.79%	0.01%	11.60%
12	28 - 17 - 26 - 25	0.00018	1.95736	0.00034	20.0	-	20.0	100.0	-	100.0	4.0	1.90257	0.00033	0.07%	7.86%	0.13%	11.73%
13	28 - 3 - 19 - 26 - 25	0.00002	1.97584	0.00005	24.0	-	24.0	120.0	-	120.0	4.0	1.91778	0.00005	0.01%	7.87%	0.02%	11.74%
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16	28 - 55 - 29 - 2 - 25	0.00016	1.66291	0.00026	20.0	1.8	19.8	80.0	7.3	79.3	3.0	1.62092	0.00026	0.06%	7.95%	0.10%	11.88%
17	28 - 55 - 29 - 4 - 25	0.00007	1.66004	0.00012	20.0	1.8	19.8	80.0	7.3	79.3	3.0	1.61855	0.00011	0.03%	7.97%	0.04%	11.92%
18	28 - 55 - 29 - 10 - 25	0.00003	1.73811	0.00005	20.0	1.8	19.8	80.0	7.3	79.3	3.0	1.68158	0.00005	0.01%	7.98%	0.02%	11.94%
19	28 - 55 - 29 - 14 - 25	0.00001	1.67053	0.00002	20.0	1.8	19.8	80.0	7.3	79.3	3.0	1.62717	0.00002	0.00%	7.99%	0.01%	11.95%
20	28 - 55 - 29 - 17 - 25	0.00020	1.88300	0.00037	20.0	1.8	19.8	80.0	7.3	79.3	3.0	1.79195	0.00036	0.08%	8.07%	0.14%	12.09%
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54	28 - 77 - 51 - 17 - 25	0.00002	1.77826	0.00004	8.0	2.0	8.0	32.0	7.8	31.8	3.0	1.71302	0.00004	0.01%	9.48%	0.02%	14.68%
55	28 - 55 - 29 - 17 - 26 - 25	0.00001	2.14382	0.00002	24.0	1.8	23.8	120.0	9.1	119.1	4.0	2.05113	0.00002	0.00%	9.48%	0.01%	14.69%
56	28 - 56 - 30 - 17 - 26 - 25	0.00001	2.40296	0.00004	24.0	1.5	23.5	144.0	9.0	141.0	5.0	2.30778	0.00003	0.01%	9.49%	0.01%	14.70%
57	28 - 65 - 39 - 17 - 26 - 25	0.00005	2.27477	0.00012	12.0	1.7	11.7	72.0	10.1	70.1	5.0	2.20432	0.00012	0.02%	9.51%	0.04%	14.75%
58	28 - 1 - 18 - 56 - 30 - 17 - 25	0.00001	2.16086	0.00003	35.0	1.5	34.5	175.0	7.5	172.5	4.0	2.06417	0.00002	0.00%	9.51%	0.01%	14.76%
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563	28 - 89 - 52 - 68 - 42 - 14 - 25	0.00002	1.72523	0.00003	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.67136	0.00003	0.01%	24.80%	0.01%	42.87%
564	28 - 89 - 52 - 68 - 42 - 17 - 25	0.00001	1.90673	0.00002	10.0	3.9	9.9	50.0	19.7	49.7	4.0	1.86036	0.00002	0.00%	24.80%	0.01%	42.88%
565	28 - 1 - 19 - 27 - 76 - 50 - 14 - 25	0.00002	2.22390	0.00004	28.0	2.0	28.0	168.0	11.9	167.9	5.0	2.16212	0.00004	0.01%	24.81%	0.01%	42.89%
566	28 - 3 - 19 - 27 - 76 - 50 - 10 - 25	0.00005	2.28409	0.00011	28.0	2.0	28.0	168.0	11.9	167.9	5.0	2.21198	0.00011	0.02%	24.83%	0.04%	42.94%
567	28 - 3 - 19 - 27 - 76 - 50 - 14 - 25	0.00012	2.22354	0.00027	28.0	2.0	28.0	168.0	11.9	167.9	5.0	2.16181	0.00026	0.05%	24.87%	0.10%	43.04%
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580	28 - 17 - 26 - 27 - 76 - 50 - 14 - 25	0.00021	2.44891	0.00051	72.0	2.0	72.0	432.0	11.9	431.9	5.0	2.34386	0.00049	0.08%	25.09%	0.19%	43.54%
581	28 - 17 - 26 - 27 - 76 - 50 - 16 - 25	0.00001	2.44420	0.00004	72.0	2.0	72.0	432.0	11.9	431.9	5.0	2.34019	0.00003	0.01%	25.10%	0.01%	43.55%
582	28 - 65 - 39 - 59 - 33 - 17 - 26 - 25	0.00002	2.53389	0.00004	20.0	3.9	17.9	120.0	23.5	107.5	5.0	2.40920	0.00004	0.01%	25.10%	0.02%	43.57%

Chemical and Metallic Sector (SChemMet) – Farm Labor (FarmL)

	Global	0.0433938			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	39 - 17 - 18	0.00149	1.51781	0.00226	4.0	-	4.0	12.0	-	12.0	2.0	1.45754	0.00217	3.43%	3.43%	4.99%	4.99%
2	39 - 6 - 18	0.00141	1.37437	0.00194	4.0	-	4.0	12.0	-	12.0	2.0	1.34659	0.00190	3.25%	6.68%	4.38%	9.38%
3	39 - 5 - 18	0.00098	1.32489	0.00130	4.0	-	4.0	12.0	-	12.0	2.0	1.30535	0.00128	2.25%	8.93%	2.94%	12.32%
4	39 - 10 - 18	0.00061	1.42633	0.00086	4.0	-	4.0	12.0	-	12.0	2.0	1.38824	0.00084	1.39%	10.33%	1.94%	14.25%
5	39 - 7 - 18	0.00015	1.31668	0.00019	4.0	-	4.0	12.0	-	12.0	2.0	1.29836	0.00019	0.34%	10.67%	0.44%	14.69%
6	39 - 14 - 18	0.00012	1.34549	0.00016	4.0	-	4.0	12.0	-	12.0	2.0	1.32271	0.00016	0.28%	10.94%	0.37%	15.06%
7	39 - 9 - 18	0.00007	1.32011	0.00010	4.0	-	4.0	12.0	-	12.0	2.0	1.30129	0.00010	0.17%	11.11%	0.22%	15.28%
8	39 - 8 - 18	0.00002	1.32291	0.00003	4.0	-	4.0	12.0	-	12.0	2.0	1.30367	0.00003	0.04%	11.16%	0.06%	15.34%
9	39 - 15 - 18	0.00001	1.29190	0.00002	4.0	-	4.0	12.0	-	12.0	2.0	1.27700	0.00002	0.03%	11.19%	0.04%	15.38%
10	39 - 17 - 26 - 18	0.00018	1.72932	0.00031	8.0	-	8.0	32.0	-	32.0	3.0	1.67461	0.00030	0.41%	11.60%	0.69%	16.07%
11	39 - 17 - 25 - 18	0.00016	1.70426	0.00027	8.0	-	8.0	32.0	-	32.0	3.0	1.65456	0.00026	0.37%	11.97%	0.61%	16.68%
12	39 - 6 - 23 - 18	0.00015	1.50619	0.00023	8.0	-	8.0	24.0	-	24.0	2.0	1.44902	0.00022	0.35%	12.33%	0.51%	17.19%
13	39 - 17 - 23 - 18	0.00007	1.67263	0.00013	8.0	-	8.0	32.0	-	32.0	3.0	1.62889	0.00012	0.17%	12.50%	0.28%	17.47%
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32	39 - 76 - 50 - 10 - 18	0.00001	1.58247	0.00002	8.0	4.0	8.0	24.0	12.0	24.0	2.0	1.50356	0.00002	0.03%	13.58%	0.04%	19.14%
33	39 - 77 - 51 - 10 - 18	0.00001	1.49216	0.00002	8.0	4.0	8.0	24.0	11.9	23.9	2.0	1.43862	0.00001	0.02%	13.60%	0.03%	19.17%
34	39 - 65 - 52 - 68 - 42 - 10 - 18	0.00003	1.66550	0.00005	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.62304	0.00005	0.06%	13.67%	0.10%	19.28%
35	39 - 89 - 52 - 68 - 42 - 10 - 18	0.00002	1.65109	0.00003	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.61117	0.00003	0.04%	13.71%	0.07%	19.35%
36	39 - 65 - 52 - 68 - 42 - 12 - 18	0.00001	1.59705	0.00002	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.56586	0.00002	0.03%	13.75%	0.05%	19.40%
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64	39 - 5 - 20 - 54 - 28 - 1 - 18	0.00002	1.86179	0.00005	23.0	1.6	22.6	92.0	6.5	90.5	3.0	1.77632	0.00004	0.06%	21.34%	0.10%	30.86%
65	39 - 6 - 23 - 56 - 30 - 2 - 18	0.00002	1.74398	0.00004	23.0	1.6	22.6	92.0	6.5	90.5	3.0	1.68622	0.00004	0.05%	21.40%	0.09%	30.95%
66	39 - 17 - 23 - 54 - 28 - 1 - 18	0.00002	1.89250	0.00004	23.0	1.5	22.5	92.0	6.0	90.0	3.0	1.79889	0.00004	0.05%	21.44%	0.09%	31.03%
67	39 - 6 - 23 - 54 - 28 - 4 - 18	0.00002	2.00550	0.00004	23.0	1.6	22.6	115.0	8.1	113.1	4.0	1.94196	0.00004	0.05%	21.49%	0.09%	31.12%
68	39 - 17 - 19 - 54 - 28 - 2 - 18	0.00002	1.81359	0.00004	23.0	1.6	22.6	92.0	6.5	90.5	3.0	1.74013	0.00003	0.05%	21.54%	0.08%	31.20%
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75	39 - 17 - 19 - 58 - 32 - 2 - 18	0.00002	1.92188	0.00003	23.0	1.6	22.6	115.0	8.1	113.1	4.0	1.87307	0.00003	0.04%	21.82%	0.07%	31.74%
76	39 - 17 - 22 - 58 - 32 - 2 - 18	0.00002	1.99467	0.00003	23.0	1.5	22.5	115.0	7.4	112.4	4.0	1.93317	0.00003	0.04%	21.86%	0.07%	31.81%
77	39 - 17 - 19 - 54 - 28 - 4 - 18	0.00002	1.84391	0.00003	23.0	1.5	22.5	92.0	5.9	89.9	3.0	1.76301	0.00003	0.04%	21.90%	0.07%	31.88%
78	39 - 6 - 23 - 58 - 32 - 1 - 18	0.00001	1.93705	0.00003	23.0	1.6	22.6	115.0	8.1	113.1	4.0	1.88573	0.00003	0.03%	21.93%	0.07%	31.94%
79	39 - 17 - 20 - 58 - 32 - 2 - 18	0.00001	1.78777	0.00003	23.0	1.5	22.5	92.0	5.9	89.9	3.0	1.72037	0.00003	0.03%	21.97%	0.06%	32.00%
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105	39 - 72 - 46 - 17 - 26 - 27 - 18	0.00001	2.21441	0.00002	68.0	3.9	67.9	340.0	19.7	339.7	4.0	2.10456	0.00002	0.02%	28.35%	0.05%	44.64%
106	39 - 59 - 33 - 17 - 26 - 27 - 18	0.00075	2.27349	0.00171	72.0	3.9	71.9	432.0	23.5	431.5	5.0	2.20327	0.00166	1.74%	30.09%	3.83%	48.47%
107	39 - 55 - 29 - 17 - 26 - 27 - 18	0.00003	2.22428	0.00006	80.0	3.8	79.8	480.0	22.9	478.9	5.0	2.16243	0.00006	0.07%	30.15%	0.14%	48.61%

Chemical and Metallic Sector (SChemMet) – Farm Entrepreneur (FarmEn)

	Global	0.192209			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	39 - 17 - 19	0.01726	1.70376	0.02941	4.0	-	4.0	16.0	-	16.0	3.0	1.65416	0.02856	8.98%	8.98%	14.86%	14.86%
2	39 - 7 - 19	0.00546	1.51824	0.00830	4.0	-	4.0	12.0	-	12.0	2.0	1.45786	0.00797	2.84%	11.82%	4.14%	19.00%
3	39 - 6 - 19	0.00471	1.58014	0.00745	4.0	-	4.0	12.0	-	12.0	2.0	1.50194	0.00708	2.45%	14.28%	3.68%	22.68%
4	39 - 5 - 19	0.00297	1.53146	0.00455	4.0	-	4.0	12.0	-	12.0	2.0	1.46746	0.00436	1.55%	15.82%	2.27%	24.95%
5	39 - 10 - 19	0.00212	1.62904	0.00345	4.0	-	4.0	16.0	-	16.0	3.0	1.59282	0.00337	1.10%	16.92%	1.76%	26.71%
6	39 - 14 - 19	0.00116	1.54982	0.00180	4.0	-	4.0	12.0	-	12.0	2.0	1.48062	0.00172	0.60%	17.53%	0.89%	27.60%
7	39 - 8 - 19	0.00020	1.53189	0.00031	4.0	-	4.0	12.0	-	12.0	2.0	1.46777	0.00029	0.10%	17.63%	0.15%	27.75%
8	39 - 15 - 19	0.00019	1.50089	0.00029	4.0	-	4.0	12.0	-	12.0	2.0	1.44510	0.00028	0.10%	17.73%	0.15%	27.90%
9	39 - 9 - 19	0.00014	1.52921	0.00021	4.0	-	4.0	12.0	-	12.0	2.0	1.46583	0.00020	0.07%	17.80%	0.10%	28.00%
10	39 - 11 - 19	0.00013	1.54943	0.00021	4.0	-	4.0	12.0	-	12.0	2.0	1.48034	0.00020	0.07%	17.87%	0.10%	28.11%
11	39 - 13 - 19	0.00007	1.52066	0.00011	4.0	-	4.0	12.0	-	12.0	2.0	1.45963	0.00010	0.04%	17.91%	0.05%	28.16%
12	39 - 16 - 19	0.00007	1.50666	0.00010	4.0	-	4.0	12.0	-	12.0	2.0	1.44936	0.00010	0.03%	17.94%	0.05%	28.21%
13	39 - 17 - 26 - 19	0.00051	1.94002	0.00100	8.0	-	8.0	40.0	-	40.0	4.0	1.88821	0.00097	0.27%	18.21%	0.51%	28.72%
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22	39 - 75 - 49 - 17 - 19	0.00008	1.77170	0.00014	8.0	3.9	7.9	32.0	15.7	31.7	3.0	1.70793	0.00013	0.04%	18.77%	0.07%	29.70%
23	39 - 72 - 46 - 17 - 19	0.00008	1.84258	0.00014	8.0	3.9	7.9	32.0	15.8	31.8	3.0	1.76201	0.00013	0.04%	18.81%	0.07%	29.77%
24	39 - 76 - 50 - 14 - 19	0.00007	1.69078	0.00012	8.0	4.0	8.0	32.0	15.9	31.9	3.0	1.64368	0.00011	0.04%	18.85%	0.06%	29.83%
25	39 - 60 - 34 - 17 - 19	0.00005	1.72210	0.00009	8.0	3.6	7.6	32.0	14.5	30.5	3.0	1.66886	0.00009	0.03%	18.87%	0.05%	29.87%
26	39 - 60 - 34 - 6 - 19	0.00005	1.59748	0.00008	8.0	3.6	7.6	32.0	14.5	30.5	3.0	1.56622	0.00008	0.03%	18.90%	0.04%	29.91%
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115	39 - 17 - 20 - 76 - 50 - 10 - 19	0.00001	2.05709	0.00003	11.0	2.0	11.0	55.0	9.9	54.9	4.0	1.98337	0.00003	0.01%	20.08%	0.01%	32.06%
116	39 - 6 - 23 - 64 - 38 - 7 - 19	0.00001	2.20128	0.00003	11.0	1.7	10.7	55.0	8.3	53.3	4.0	2.09474	0.00003	0.01%	20.08%	0.01%	32.07%
117	39 - 5 - 20 - 75 - 49 - 17 - 19	0.00001	1.89113	0.00002	11.0	1.9	10.9	44.0	7.7	43.7	3.0	1.79789	0.00002	0.01%	20.09%	0.01%	32.09%
118	39 - 17 - 23 - 61 - 35 - 7 - 19	0.00001	2.36427	0.00003	11.0	1.6	10.6	66.0	9.5	63.5	5.0	2.27699	0.00003	0.01%	20.10%	0.01%	32.10%
119	39 - 10 - 23 - 76 - 50 - 14 - 19	0.00001	1.93396	0.00002	11.0	2.0	11.0	55.0	9.9	54.9	4.0	1.88316	0.00002	0.01%	20.10%	0.01%	32.11%
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121	39 - 17 - 25 - 64 - 38 - 6 - 19	0.00001	2.44762	0.00003	11.0	1.7	10.7	66.0	10.0	64.0	5.0	2.34286	0.00003	0.01%	20.12%	0.01%	32.14%
122	39 - 6 - 23 - 74 - 48 - 17 - 19	0.00001	2.36320	0.00003	11.0	2.0	11.0	66.0	11.9	65.9	5.0	2.27613	0.00003	0.01%	20.12%	0.01%	32.15%
123	39 - 17 - 25 - 76 - 50 - 13 - 19	0.00001	2.00334	0.00002	11.0	2.0	11.0	55.0	9.9	54.9	4.0	1.94021	0.00002	0.01%	20.13%	0.01%	32.16%
124	39 - 6 - 23 - 66 - 40 - 17 - 19	0.00001	2.01002	0.00002	11.0	2.0	11.0	55.0	9.8	54.8	4.0	1.94562	0.00002	0.01%	20.13%	0.01%	32.17%
125	39 - 17 - 22 - 61 - 35 - 7 - 19	0.00001	2.30714	0.00003	11.0	1.6	10.6	66.0	9.5	63.5	5.0	2.23084	0.00002	0.01%	20.14%	0.01%	32.19%
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303	39 - 72 - 46 - 17 - 26 - 27 - 19	0.00001	2.47107	0.00003	68.0	3.9	67.9	408.0	23.6	407.6	5.0	2.36107	0.00003	0.01%	34.08%	0.02%	57.90%
304	39 - 59 - 33 - 17 - 26 - 27 - 19	0.00092	2.54697	0.00235	72.0	3.9	71.9	504.0	27.4	503.4	6.0	2.46931	0.00228	0.48%	34.56%	1.19%	59.09%
305	39 - 55 - 29 - 17 - 26 - 27 - 19	0.00004	2.46463	0.00009	80.0	3.8	79.8	480.0	22.9	478.9	5.0	2.35608	0.00008	0.02%	34.58%	0.04%	59.13%

Chemical and Metallic Sector (SChemMet) – Low Entrepreneur in Rural area (LoEnRu)

	Global	0.1194818			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	39 - 5 - 20	0.01455	1.36908	0.01992	4.0	-	4.0	12.0	-	12.0	2.0	1.34226	0.01953	12.18%	12.18%	16.35%	16.35%
2	39 - 17 - 20	0.01191	1.56538	0.01865	4.0	-	4.0	12.0	-	12.0	2.0	1.49163	0.01777	9.97%	22.15%	14.87%	31.22%
3	39 - 7 - 20	0.00275	1.38031	0.00380	4.0	-	4.0	12.0	-	12.0	2.0	1.35144	0.00372	2.30%	24.45%	3.11%	34.33%
4	39 - 9 - 20	0.00084	1.37705	0.00116	4.0	-	4.0	12.0	-	12.0	2.0	1.34878	0.00113	0.70%	25.15%	0.95%	35.28%
5	39 - 11 - 20	0.00073	1.38015	0.00100	4.0	-	4.0	12.0	-	12.0	2.0	1.35131	0.00098	0.61%	25.76%	0.82%	36.10%
6	39 - 15 - 20	0.00058	1.35804	0.00079	4.0	-	4.0	12.0	-	12.0	2.0	1.33315	0.00078	0.49%	26.25%	0.65%	36.75%
7	39 - 13 - 20	0.00009	1.37793	0.00012	4.0	-	4.0	12.0	-	12.0	2.0	1.34950	0.00012	0.07%	26.32%	0.10%	36.85%
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13	39 - 6 - 23 - 20	0.00011	1.57593	0.00018	8.0	-	8.0	24.0	-	24.0	2.0	1.49901	0.00017	0.09%	27.37%	0.14%	38.50%
14	39 - 60 - 34 - 7 - 20	0.00011	1.39540	0.00015	8.0	3.6	7.6	24.0	10.9	22.9	2.0	1.36366	0.00015	0.09%	27.46%	0.12%	38.62%
15	39 - 71 - 45 - 5 - 20	0.00010	1.44137	0.00015	8.0	3.9	7.9	24.0	11.8	23.8	2.0	1.39999	0.00014	0.08%	27.54%	0.12%	38.74%
16	39 - 64 - 38 - 5 - 20	0.00008	1.80024	0.00015	8.0	3.7	7.7	32.0	14.7	30.7	3.0	1.72995	0.00014	0.07%	27.61%	0.12%	38.86%
17	39 - 69 - 43 - 11 - 20	0.00008	1.48182	0.00011	8.0	3.9	7.9	24.0	11.8	23.8	2.0	1.43088	0.00011	0.06%	27.67%	0.09%	38.95%
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54	39 - 65 - 52 - 68 - 42 - 11 - 20	0.00067	1.61065	0.00108	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.57737	0.00106	0.56%	29.10%	0.89%	41.20%
55	39 - 89 - 52 - 68 - 42 - 11 - 20	0.00047	1.59656	0.00075	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.56544	0.00073	0.39%	29.49%	0.61%	41.82%
56	39 - 55 - 52 - 68 - 42 - 11 - 20	0.00016	1.73949	0.00029	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.68267	0.00028	0.14%	29.63%	0.23%	42.05%
57	39 - 64 - 52 - 68 - 42 - 11 - 20	0.00008	2.01768	0.00016	10.0	3.9	9.9	50.0	19.7	49.7	4.0	1.95181	0.00016	0.07%	29.70%	0.13%	42.18%
58	39 - 65 - 52 - 68 - 42 - 9 - 20	0.00008	1.61902	0.00012	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.58442	0.00012	0.06%	29.76%	0.10%	42.28%
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90	39 - 6 - 23 - 75 - 49 - 17 - 20	0.00002	1.80712	0.00004	11.0	1.9	10.9	44.0	7.7	43.7	3.0	1.73521	0.00004	0.02%	30.75%	0.04%	44.03%
91	39 - 6 - 23 - 69 - 43 - 9 - 20	0.00002	1.67944	0.00004	11.0	1.9	10.9	44.0	7.7	43.7	3.0	1.63445	0.00004	0.02%	30.77%	0.03%	44.07%
92	39 - 10 - 25 - 69 - 43 - 11 - 20	0.00002	1.74638	0.00004	11.0	1.9	10.9	44.0	7.7	43.7	3.0	1.68811	0.00004	0.02%	30.79%	0.03%	44.10%
93	39 - 6 - 23 - 71 - 45 - 5 - 20	0.00002	1.64531	0.00004	11.0	1.9	10.9	44.0	7.8	43.8	3.0	1.60638	0.00004	0.02%	30.81%	0.03%	44.13%
94	39 - 6 - 23 - 64 - 38 - 17 - 20	0.00002	2.18170	0.00005	11.0	1.7	10.7	55.0	8.3	53.3	4.0	2.07999	0.00005	0.02%	30.82%	0.04%	44.17%
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100	39 - 14 - 25 - 69 - 43 - 11 - 20	0.00002	1.69429	0.00003	11.0	1.9	10.9	44.0	7.7	43.7	3.0	1.64652	0.00003	0.01%	30.92%	0.02%	44.34%
101	39 - 17 - 25 - 76 - 50 - 9 - 20	0.00002	1.87669	0.00003	11.0	2.0	11.0	44.0	7.9	43.9	3.0	1.78732	0.00003	0.01%	30.93%	0.03%	44.37%
102	39 - 7 - 22 - 69 - 43 - 11 - 20	0.00002	1.60258	0.00003	11.0	1.9	10.9	44.0	7.7	43.7	3.0	1.57055	0.00003	0.01%	30.95%	0.02%	44.39%
103	39 - 10 - 23 - 69 - 43 - 11 - 20	0.00002	1.73584	0.00003	11.0	1.9	10.9	44.0	7.7	43.7	3.0	1.67979	0.00003	0.01%	30.96%	0.02%	44.42%
104	39 - 17 - 24 - 69 - 43 - 11 - 20	0.00002	1.71941	0.00003	11.0	1.9	10.9	44.0	7.7	43.7	3.0	1.66671	0.00003	0.01%	30.97%	0.02%	44.44%
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198	39 - 72 - 46 - 17 - 26 - 27 - 20	0.00001	2.27660	0.00002	68.0	3.9	67.9	408.0	23.6	407.6	5.0	2.20582	0.00002	0.01%	40.88%	0.02%	61.60%
199	39 - 59 - 33 - 17 - 26 - 27 - 20	0.00075	2.34305	0.00176	72.0	3.9	71.9	432.0	23.5	431.5	5.0	2.25994	0.00170	0.63%	41.50%	1.42%	63.02%
200	39 - 55 - 29 - 17 - 26 - 27 - 20	0.00003	2.29204	0.00007	80.0	3.8	79.8	480.0	22.9	478.9	5.0	2.21850	0.00006	0.02%	41.53%	0.05%	63.07%

Chemical and Metallic Sector (SChemMet) – High Entrepreneur in Rural area (HiEnRu)

	Global	0.1276195			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	39 - 17 - 22	0.01848	1.55796	0.02878	4.0	-	4.0	12.0	-	12.0	2.0	1.48639	0.02746	14.48%	14.48%	21.52%	21.52%
2	39 - 7 - 22	0.00705	1.37179	0.00968	4.0	-	4.0	12.0	-	12.0	2.0	1.34448	0.00948	5.53%	20.00%	7.43%	28.95%
3	39 - 5 - 22	0.00180	1.38858	0.00249	4.0	-	4.0	12.0	-	12.0	2.0	1.35815	0.00244	1.41%	21.41%	1.91%	30.86%
4	39 - 9 - 22	0.00137	1.36925	0.00188	4.0	-	4.0	12.0	-	12.0	2.0	1.34240	0.00184	1.07%	22.49%	1.44%	32.30%
5	39 - 13 - 22	0.00071	1.36213	0.00097	4.0	-	4.0	12.0	-	12.0	2.0	1.33654	0.00095	0.56%	23.04%	0.75%	33.05%
6	39 - 11 - 22	0.00039	1.39403	0.00054	4.0	-	4.0	12.0	-	12.0	2.0	1.36255	0.00053	0.31%	23.35%	0.42%	33.46%
7	39 - 15 - 22	0.00033	1.35579	0.00045	4.0	-	4.0	12.0	-	12.0	2.0	1.33129	0.00045	0.26%	23.61%	0.35%	33.81%
8	39 - 17 - 26 - 22	0.00084	1.77464	0.00148	8.0	-	8.0	32.0	-	32.0	3.0	1.71021	0.00143	0.66%	24.27%	1.12%	34.93%
9	39 - 60 - 34 - 7 - 22	0.00028	1.38710	0.00039	8.0	3.6	7.6	24.0	10.9	22.9	2.0	1.35695	0.00038	0.22%	24.49%	0.30%	35.23%
10	39 - 76 - 50 - 13 - 22	0.00024	1.52226	0.00037	8.0	4.0	8.0	24.0	12.0	24.0	2.0	1.46078	0.00035	0.19%	24.68%	0.28%	35.51%
11	39 - 74 - 48 - 17 - 22	0.00019	1.96606	0.00037	8.0	4.0	8.0	40.0	19.9	39.9	4.0	1.90974	0.00036	0.15%	24.82%	0.28%	35.79%
12	39 - 66 - 40 - 17 - 22	0.00018	1.66652	0.00029	8.0	4.0	8.0	32.0	15.8	31.8	3.0	1.62388	0.00029	0.14%	24.96%	0.22%	36.02%
13	39 - 74 - 48 - 9 - 22	0.00010	1.75352	0.00018	8.0	4.0	8.0	32.0	15.9	31.9	3.0	1.69373	0.00017	0.08%	25.04%	0.13%	36.15%
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20	39 - 71 - 45 - 7 - 22	0.00005	1.44589	0.00007	8.0	3.9	7.9	24.0	11.8	23.8	2.0	1.40349	0.00007	0.04%	25.41%	0.06%	36.75%
21	39 - 64 - 38 - 7 - 22	0.00005	1.80345	0.00008	8.0	3.7	7.7	32.0	14.7	30.7	3.0	1.73241	0.00008	0.04%	25.45%	0.06%	36.81%
22	39 - 69 - 43 - 11 - 22	0.00004	1.48971	0.00006	8.0	3.9	7.9	24.0	11.8	23.8	2.0	1.43679	0.00006	0.03%	25.48%	0.05%	36.86%
23	39 - 72 - 46 - 7 - 22	0.00004	1.50737	0.00006	8.0	3.9	7.9	24.0	11.8	23.8	2.0	1.44989	0.00006	0.03%	25.51%	0.05%	36.90%
24	39 - 77 - 51 - 9 - 22	0.00004	1.44590	0.00005	8.0	4.0	8.0	24.0	11.9	23.9	2.0	1.40350	0.00005	0.03%	25.54%	0.04%	36.94%
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77	39 - 6 - 23 - 75 - 49 - 17 - 22	0.00004	1.79977	0.00007	11.0	1.9	10.9	44.0	7.7	43.7	3.0	1.72959	0.00007	0.03%	27.69%	0.05%	40.50%
78	39 - 14 - 25 - 76 - 50 - 13 - 22	0.00003	1.71551	0.00006	11.0	2.0	11.0	44.0	7.9	43.9	3.0	1.66359	0.00006	0.03%	27.71%	0.04%	40.54%
79	39 - 6 - 23 - 64 - 38 - 17 - 22	0.00003	2.17537	0.00007	11.0	1.7	10.7	55.0	8.3	53.3	4.0	2.07520	0.00007	0.03%	27.74%	0.05%	40.60%
80	39 - 6 - 23 - 61 - 35 - 7 - 22	0.00003	2.11897	0.00007	11.0	1.6	10.6	55.0	7.9	52.9	4.0	2.03196	0.00007	0.03%	27.77%	0.05%	40.65%
81	39 - 17 - 21 - 76 - 50 - 13 - 22	0.00003	1.73424	0.00006	11.0	2.0	11.0	44.0	7.9	43.9	3.0	1.67852	0.00005	0.03%	27.79%	0.04%	40.69%
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100	39 - 17 - 19 - 61 - 35 - 7 - 22	0.00002	2.30714	0.00004	11.0	1.6	10.6	66.0	9.5	63.5	5.0	2.23084	0.00004	0.01%	28.16%	0.03%	41.35%
101	39 - 17 - 25 - 61 - 35 - 7 - 22	0.00002	2.29212	0.00004	11.0	1.6	10.6	66.0	9.5	63.5	5.0	2.21856	0.00004	0.01%	28.18%	0.03%	41.38%
102	39 - 6 - 25 - 76 - 50 - 13 - 22	0.00002	1.78611	0.00003	11.0	2.0	11.0	44.0	7.9	43.9	3.0	1.71909	0.00003	0.01%	28.19%	0.02%	41.40%
103	39 - 5 - 19 - 76 - 50 - 13 - 22	0.00002	1.81937	0.00003	11.0	2.0	11.0	44.0	7.9	43.9	3.0	1.74453	0.00003	0.01%	28.21%	0.02%	41.43%
104	39 - 6 - 23 - 64 - 38 - 7 - 22	0.00002	2.02267	0.00003	11.0	1.7	10.7	55.0	8.3	53.3	4.0	1.95584	0.00003	0.01%	28.22%	0.03%	41.45%
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220	39 - 17 - 26 - 27 - 77 - 51 - 9 - 22	0.00001	2.19990	0.00002	60.0	2.0	60.0	300.0	9.8	299.8	4.0	2.09370	0.00002	0.01%	39.11%	0.02%	60.24%
221	39 - 6 - 23 - 27 - 76 - 50 - 13 - 22	0.00001	2.12578	0.00002	60.0	2.0	60.0	300.0	9.9	299.9	4.0	2.03723	0.00002	0.01%	39.11%	0.02%	60.26%
222	39 - 17 - 26 - 27 - 76 - 50 - 7 - 22	0.00001	2.29481	0.00002	60.0	2.0	60.0	360.0	11.9	359.9	5.0	2.22076	0.00002	0.01%	39.12%	0.02%	60.27%

Chemical and Metallic Sector (SChemMet) – Low Entrepreneur in Urban area (LoEnUr)

	Global	0.1869986			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	39 - 6 - 23	0.03509	1.43798	0.05046	4.0	-	4.0	12.0	-	12.0	2.0	1.39735	0.04904	18.77%	18.77%	26.22%	26.22%
2	39 - 17 - 23	0.01703	1.60928	0.02741	4.0	-	4.0	16.0	-	16.0	3.0	1.57621	0.02684	9.11%	27.87%	14.36%	40.58%
3	39 - 10 - 23	0.00603	1.50724	0.00909	4.0	-	4.0	12.0	-	12.0	2.0	1.44979	0.00875	3.23%	31.10%	4.68%	45.26%
4	39 - 8 - 23	0.00382	1.42309	0.00544	4.0	-	4.0	12.0	-	12.0	2.0	1.38569	0.00530	2.04%	33.14%	2.83%	48.09%
5	39 - 16 - 23	0.00062	1.41638	0.00088	4.0	-	4.0	12.0	-	12.0	2.0	1.38039	0.00086	0.33%	33.48%	0.46%	48.55%
6	39 - 14 - 23	0.00045	1.46409	0.00066	4.0	-	4.0	12.0	-	12.0	2.0	1.41746	0.00064	0.24%	33.72%	0.34%	48.89%
7	39 - 12 - 23	0.00004	1.47671	0.00005	4.0	-	4.0	12.0	-	12.0	2.0	1.42703	0.00005	0.02%	33.74%	0.03%	48.92%
8	39 - 17 - 26 - 23	0.00102	1.83289	0.00187	8.0	-	8.0	32.0	-	32.0	3.0	1.75474	0.00179	0.54%	34.28%	0.95%	49.87%
9	39 - 60 - 34 - 6 - 23	0.00036	1.45387	0.00053	8.0	3.6	7.6	24.0	10.9	22.9	2.0	1.40964	0.00051	0.19%	34.48%	0.27%	50.15%
10	39 - 64 - 38 - 6 - 23	0.00034	1.85332	0.00063	8.0	3.7	7.7	32.0	14.7	30.7	3.0	1.77003	0.00060	0.18%	34.66%	0.32%	50.47%
11	39 - 74 - 48 - 10 - 23	0.00025	1.91174	0.00047	8.0	4.0	8.0	40.0	19.9	39.9	4.0	1.86457	0.00046	0.13%	34.79%	0.25%	50.71%
12	39 - 60 - 34 - 8 - 23	0.00024	1.43885	0.00034	8.0	3.6	7.6	24.0	10.9	22.9	2.0	1.39802	0.00033	0.13%	34.92%	0.18%	50.89%
13	39 - 74 - 48 - 17 - 23	0.00017	2.02650	0.00035	8.0	4.0	8.0	40.0	19.9	39.9	4.0	1.95892	0.00034	0.09%	35.01%	0.18%	51.07%
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17	39 - 17 - 25 - 23	0.00012	1.79451	0.00021	8.0	-	8.0	32.0	-	32.0	3.0	1.72555	0.00020	0.06%	35.33%	0.11%	51.57%
18	39 - 76 - 50 - 10 - 23	0.00011	1.65445	0.00018	8.0	4.0	8.0	32.0	15.9	31.9	3.0	1.61394	0.00018	0.06%	35.39%	0.09%	51.66%
19	39 - 77 - 51 - 6 - 23	0.00010	1.50262	0.00016	8.0	4.0	8.0	24.0	11.9	23.9	2.0	1.44639	0.00015	0.06%	35.44%	0.08%	51.74%
20	39 - 77 - 51 - 10 - 23	0.00010	1.56349	0.00016	8.0	4.0	8.0	24.0	11.9	23.9	2.0	1.49030	0.00015	0.05%	35.50%	0.08%	51.82%
21	39 - 64 - 38 - 17 - 23	0.00008	2.03212	0.00017	8.0	3.7	7.7	40.0	18.3	38.3	4.0	1.96344	0.00017	0.05%	35.54%	0.09%	51.91%
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97	39 - 61 - 52 - 68 - 42 - 12 - 23	0.00001	2.19070	0.00003	10.0	3.9	9.9	50.0	19.7	49.7	4.0	2.08679	0.00003	0.01%	37.45%	0.02%	55.05%
98	39 - 60 - 52 - 68 - 42 - 12 - 23	0.00001	1.68079	0.00002	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.63555	0.00002	0.01%	37.46%	0.01%	55.06%
99	39 - 64 - 52 - 68 - 42 - 6 - 23	0.00001	2.07332	0.00003	10.0	3.9	9.9	50.0	19.7	49.7	4.0	1.99623	0.00003	0.01%	37.47%	0.01%	55.08%
100	39 - 60 - 53 - 71 - 45 - 6 - 23	0.00001	1.52805	0.00002	10.0	3.9	9.9	30.0	11.8	29.8	2.0	1.46499	0.00002	0.01%	37.48%	0.01%	55.09%
101	39 - 65 - 53 - 73 - 47 - 10 - 23	0.00001	1.65388	0.00002	10.0	3.9	9.9	40.0	15.6	39.6	3.0	1.61347	0.00002	0.01%	37.48%	0.01%	55.10%
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104	39 - 84 - 52 - 68 - 42 - 10 - 23	0.00001	1.70823	0.00002	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.65776	0.00002	0.01%	37.50%	0.01%	55.13%
105	39 - 84 - 52 - 68 - 42 - 12 - 23	0.00001	1.66377	0.00002	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.62162	0.00002	0.01%	37.51%	0.01%	55.14%
106	39 - 17 - 25 - 64 - 38 - 6 - 23	0.00009	2.25143	0.00020	11.0	1.7	10.7	66.0	10.0	64.0	5.0	2.18503	0.00019	0.05%	37.55%	0.10%	55.24%
107	39 - 17 - 19 - 61 - 35 - 6 - 23	0.00008	2.36546	0.00019	11.0	1.6	10.6	66.0	9.5	63.5	5.0	2.27795	0.00019	0.04%	37.60%	0.10%	55.34%
108	39 - 17 - 25 - 61 - 35 - 6 - 23	0.00008	2.34193	0.00019	11.0	1.6	10.6	66.0	9.5	63.5	5.0	2.25904	0.00018	0.04%	37.64%	0.10%	55.44%
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286	39 - 66 - 40 - 17 - 26 - 27 - 23	0.00002	2.30822	0.00004	68.0	4.0	68.0	408.0	23.8	407.8	5.0	2.23171	0.00004	0.01%	46.25%	0.02%	70.91%
287	39 - 59 - 33 - 17 - 26 - 27 - 23	0.00053	2.40587	0.00128	72.0	3.9	71.9	432.0	23.5	431.5	5.0	2.31008	0.00123	0.28%	46.53%	0.66%	71.57%
288	39 - 55 - 29 - 17 - 26 - 27 - 23	0.00002	2.35715	0.00005	80.0	3.8	79.8	480.0	22.9	478.9	5.0	2.27128	0.00005	0.01%	46.54%	0.02%	71.59%

Chemical and Metallic Sector (SChemMet) – High Entrepreneur in Urban area (HiEnUr)

	Global	0.2150579			Time direct			Time with loops			Rounds	Multip.	Total	Direct	Direct	Total	Total
No.	Paths	Direct	Mult	Total	fixed	variable	mixed	fixed	variable	mixed	for 95%	for 95%	for 95%	% of glob	cumul.	% of glob	cumul.
1	39 - 17 - 25	0.02501	1.64121	0.04105	4.0	-	4.0	16.0	-	16.0	3.0	1.60297	0.04009	11.63%	11.63%	18.64%	18.64%
2	39 - 10 - 25	0.01017	1.52835	0.01554	4.0	-	4.0	12.0	-	12.0	2.0	1.46521	0.01490	4.73%	16.36%	6.93%	25.57%
3	39 - 14 - 25	0.00748	1.46418	0.01095	4.0	-	4.0	12.0	-	12.0	2.0	1.41753	0.01060	3.48%	19.83%	4.93%	30.50%
4	39 - 6 - 25	0.00398	1.53148	0.00609	4.0	-	4.0	12.0	-	12.0	2.0	1.46747	0.00584	1.85%	21.68%	2.71%	33.21%
5	39 - 8 - 25	0.00231	1.47297	0.00341	4.0	-	4.0	12.0	-	12.0	2.0	1.42420	0.00330	1.08%	22.76%	1.53%	34.74%
6	39 - 16 - 25	0.00206	1.45201	0.00298	4.0	-	4.0	12.0	-	12.0	2.0	1.40821	0.00289	0.96%	23.72%	1.35%	36.09%
7	39 - 12 - 25	0.00017	1.47543	0.00024	4.0	-	4.0	12.0	-	12.0	2.0	1.42607	0.00024	0.08%	23.79%	0.11%	36.20%
8	39 - 17 - 26 - 25	0.00126	1.86914	0.00235	8.0	-	8.0	32.0	-	32.0	3.0	1.78175	0.00224	0.59%	24.38%	1.04%	37.24%
9	39 - 76 - 50 - 14 - 25	0.00045	1.59707	0.00072	8.0	4.0	8.0	32.0	15.9	31.9	3.0	1.56587	0.00070	0.21%	24.59%	0.33%	37.57%
10	39 - 74 - 48 - 10 - 25	0.00041	1.93312	0.00080	8.0	4.0	8.0	40.0	19.9	39.9	4.0	1.88246	0.00078	0.19%	24.78%	0.36%	37.93%
11	39 - 74 - 48 - 17 - 25	0.00026	2.05985	0.00053	8.0	4.0	8.0	40.0	19.9	39.9	4.0	1.98557	0.00051	0.12%	24.90%	0.24%	38.17%
12	39 - 66 - 40 - 17 - 25	0.00024	1.75378	0.00042	8.0	4.0	8.0	32.0	15.8	31.8	3.0	1.69393	0.00040	0.11%	25.01%	0.19%	38.36%
13	39 - 74 - 48 - 14 - 25	0.00019	1.86060	0.00035	8.0	4.0	8.0	32.0	15.9	31.9	3.0	1.77544	0.00033	0.09%	25.10%	0.15%	38.51%
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16	39 - 77 - 51 - 10 - 25	0.00017	1.58548	0.00027	8.0	4.0	8.0	32.0	15.8	31.8	3.0	1.55600	0.00027	0.08%	25.35%	0.12%	38.90%
17	39 - 60 - 34 - 8 - 25	0.00014	1.48936	0.00022	8.0	3.6	7.6	24.0	10.9	22.9	2.0	1.43653	0.00021	0.07%	25.41%	0.10%	38.99%
18	39 - 72 - 46 - 10 - 25	0.00014	1.66130	0.00024	8.0	3.9	7.9	32.0	15.8	31.8	3.0	1.61959	0.00023	0.07%	25.48%	0.11%	39.10%
19	39 - 64 - 38 - 17 - 25	0.00012	2.07526	0.00026	8.0	3.7	7.7	40.0	18.3	38.3	4.0	1.99777	0.00025	0.06%	25.54%	0.12%	39.22%
20	39 - 75 - 49 - 17 - 25	0.00011	1.69814	0.00019	8.0	3.9	7.9	32.0	15.7	31.7	3.0	1.64963	0.00019	0.05%	25.59%	0.09%	39.30%
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104	39 - 65 - 53 - 72 - 46 - 14 - 25	0.00001	1.65702	0.00002	10.0	3.9	9.9	40.0	15.8	39.8	3.0	1.61606	0.00002	0.01%	28.43%	0.01%	44.03%
105	39 - 55 - 52 - 68 - 42 - 17 - 25	0.00001	1.98128	0.00002	10.0	3.9	9.9	50.0	19.7	49.7	4.0	1.92224	0.00002	0.01%	28.43%	0.01%	44.04%
106	39 - 55 - 53 - 71 - 45 - 8 - 25	0.00001	1.69857	0.00002	10.0	3.9	9.9	40.0	15.8	39.8	3.0	1.64997	0.00002	0.01%	28.44%	0.01%	44.05%
107	39 - 88 - 52 - 68 - 42 - 10 - 25	0.00001	1.70766	0.00002	10.0	3.9	9.9	40.0	15.7	39.7	3.0	1.65730	0.00002	0.00%	28.45%	0.01%	44.05%
108	39 - 65 - 53 - 71 - 45 - 12 - 25	0.00001	1.58382	0.00002	10.0	3.9	9.9	40.0	15.8	39.8	3.0	1.55458	0.00002	0.00%	28.45%	0.01%	44.06%
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110	39 - 6 - 23 - 76 - 50 - 14 - 25	0.00046	1.78600	0.00083	11.0	2.0	11.0	44.0	7.9	43.9	3.0	1.71900	0.00079	0.21%	28.67%	0.37%	44.44%
111	39 - 6 - 23 - 69 - 43 - 12 - 25	0.00023	1.73642	0.00040	11.0	1.9	10.9	44.0	7.7	43.7	3.0	1.68024	0.00039	0.11%	28.78%	0.18%	44.62%
112	39 - 17 - 23 - 76 - 50 - 14 - 25	0.00022	1.89729	0.00043	11.0	2.0	11.0	55.0	9.9	54.9	4.0	1.85240	0.00042	0.10%	28.88%	0.19%	44.81%
113	39 - 5 - 20 - 76 - 50 - 14 - 25	0.00019	1.73690	0.00033	11.0	2.0	11.0	44.0	7.9	43.9	3.0	1.68063	0.00032	0.09%	28.97%	0.15%	44.96%
114	39 - 6 - 23 - 76 - 50 - 10 - 25	0.00019	1.81083	0.00034	11.0	2.0	11.0	44.0	7.9	43.9	3.0	1.73804	0.00033	0.09%	29.06%	0.15%	45.11%
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337	39 - 17 - 26 - 27 - 72 - 46 - 10 - 25	0.00002	2.47157	0.00004	60.0	1.9	59.9	360.0	11.6	359.6	5.0	2.36146	0.00004	0.01%	38.92%	0.02%	63.03%
338	39 - 17 - 26 - 27 - 77 - 51 - 14 - 25	0.00002	2.29197	0.00004	60.0	2.0	60.0	360.0	11.7	359.7	5.0	2.21844	0.00003	0.01%	38.92%	0.02%	63.05%
339	39 - 17 - 22 - 27 - 76 - 50 - 14 - 25	0.00001	2.24591	0.00003	60.0	2.0	60.0	360.0	11.9	359.9	5.0	2.18045	0.00003	0.01%	38.93%	0.01%	63.06%

APPENDIX 2C

ADDITIONAL INFORMATION

The 2008 Indonesian SAM structure consists of:

- Factor of productions: 16 Labor and 1 Non-Labor
- Institutions: 8 Households (6 well defined and 2 not well defined households), 1 Government and 1 Enterprise
- Production sectors: 24 sectors
- Domestic commodities: 24 commodities
- Import commodities: 24 commodities
- 1 Transport margin and 1 Trade margin
- Other sectors: Capital account, Indirect taxes, Subsidies and External sector.

CHAPTER 3

AN ECONOMETRIC EXAMINATION OF IMPACTS OF MONETARY POLICY ON THE WELFARE OF DIFFERENT INCOME GROUPS IN INDONESIA USING A DYNAMIC DEMAND SYSTEM APPROACH

3.1.Introduction

Since 2002, the official monetary policy of the Bank of Indonesia has been one of inflation targeting.[1] The Bank also establishes in-house targeted rates of growth of the money supply (M2), however. It is well understood that the rate of growth of the money supply affects the abilities of consumers to realize their expenditure plans, through its impact on their access to liquidity. (See, e.g., Deaton, 1992.) Hence, monetary policy can affect the welfare derived from consumption. What is not well established is how monetary policy affects the welfare levels of members of different income groups. Intuitively, one would expect that those who are more dependent on cash for transactions (i.e., lower-income consumers) would be more directly affected than those who are not (i.e., higher-income consumers).

While some studies have been undertaken to estimate the impact of fiscal and monetary policies on the welfare levels of different income groups in Indonesia, none to our knowledge has examined the effects on welfare levels of changes in a broad money aggregate through the effects of such changes on adjustments in expenditure shares in a demand system.

Moreover, most published studies on the effects of monetary policy use a simple-sum measure of the aggregate money stock as a measure of broad money, instead of a component-share-weighted stock index or, better yet, a flow index. Barnett, Fisher,

[1] Inflation targeting policies determine the discount rate set by monetary authorities.

and Serletis (1992) have argued that an appropriate measure of broad money to employ in studying consumer demand systems is the Divisia index, which captures the *flow of financial services* from monetary assets.

To depict the influence of monetary policy on consumer welfare through its effects on adjustments in expenditure shares, one must first specify a demand system. The Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980) has been a popular choice in many studies because the flexibility of the underlying functional forms it embodies contributes to excellent empirical results. The AIDS model has some drawbacks (is *almost* ideal), however, in that it is not globally regular. If regularity is violated for given observations, then received demand theory cannot be drawn upon to sanction inferences from empirical findings for those observations. The AIDS model is derived from a utility function that is dual to a price-independent generalized logarithmic (PIGLOG) cost function. Cooper and McLaren (1983) provide a more general demand system specification that is derived from a utility function that is dual to a modified price-independent generalized logarithmic (or MPIGLOG) cost function. This demand system is regular over a wider domain of the economic region and, for some choices of component price indices, is globally regular. This demand system has been employed in a dynamic analysis of demand for world monies by Donaghy and Richard (2006) and in numerical simulation studies of transportation demand by Donaghy (2010), *inter alia.* The modeling work presented in this paper adopts the MPIGLOG specification employed in Donaghy (2010).

The MPIGLOG cost function specification gives rise to another important attribute of the utility function that is dual to it for the investigation of the effects of monetary policy on consumer welfare: it is *non-homothetic* whereas the utility function associated with the PIGLOG specification is not. Expenditure shares in a demand system based on the MPIGLOG specification will change as aggregate consumer expenditure levels change.

This paper explores the impacts of monetary policy on the welfare of people in different income groups in Indonesia. As noted above, the preferences of income groups' members are represented by a non-homothetic utility function to capture the sensitivity of expenditure shares to changes in income groups' aggregate expenditure levels. The dynamic system of demand equations for each income group is specified on the basis of Cooper and McLaren's (1992) MPIGLOG demand system and Anderson and Blundell's (1983) disequilibrium adjustment mechanism. In the model, income groups adjust their shares of expenditure on food, housing, and other items to partial-equilibrium levels as a function of commodity prices and their respective aggregate expenditure levels. These adjustments are taken to be functions of the rate of change in the flow of financial services, which is measured as a Divisia aggregate. Changes in the growth rate of the money supply (M2), which are determined by Bank of Indonesia policy, influence income groups' commodity expenditure levels, and hence levels of welfare derived from consumption of commodities, through the Divisia aggregate to which they contribute. The continuous-time model is estimated from annual time-series data on expenditures, prices, and financial aggregates by a quasi-Newton maximum-likelihood procedure. The estimation results and deterministic numerical simulations conducted with the estimated model suggest that the welfare of the low-income group is affected more by monetary policy than is that of the high-income group. They also suggest that the low-income group's expenditures on food consumption are more responsive to monetary policy than are the high-income group's, but its expenditures on housing and other commodities are less so.

The paper will be divided into five sections. The first and second sections provide a review of relevant literature on prices and low-income groups, monetary policies, and demands for money in Indonesia. The third section provides an in-depth discussion of the methodology and data used in this research. The last two sections discuss the results obtained and conclusions reached as well as future research that can be undertaken on the basis of our findings.

3.2. Literature Review

Most of the research that relates fiscal and monetary policies to poverty reduction and income inequality has been conducted either by using a computable general equilibrium approach or a discreet econometric one (Maipita, Zantan and Razak (2010), Pakpahan, Suryadarma, and Suryahadi (2009), Azis (2008), Thorbecke (2006), Damuri and Perdana (2003), and Suryatie and Tjiptoherijanto (2001)). These studies have measured the impact of fiscal and monetary policies as well as economic growth on different income groups and the inequality between those groups. In general, though, high economic growth has been found to have a significant correlation with poverty reduction especially when accompanied by relatively stable exchange rates, easiness of credit market access, improvement in human capital, reduction of labor market distortions and improvement of access to trade markets.

A large price increase could affect the low-income group by reducing disposable income as nominal wages fail to increase as quickly as prices in the case of higher inflation. Using Brazilian data, Cardoso has shown that higher inflation can increase poverty. He has also shown how partial indexation, in the absence of perfect indexation, may not satisfactorily compensate the poor for higher prices. Furthermore, Powers (1995) found that price increases could have more adverse effects on poverty when the poverty measure was based on consumption rather than income. Using US poverty data from 1959 to 1992, she found a strong positive effect of the unemployment rate on the poverty rate.

The *a priori* argument is that the low-income group should be affected more by inflation because its members depend more on the state-determined income, which is not fully indexed with inflation. In this sense, when inflation occurs, their real income will be reduced by the amount of inflation. On the other side, the low-income group is also vulnerable to inflation because their liquidity preference is greater than that of the rich. This vulnerability is also related to their shallow reach to the financial market and their inability to obtain full access to the credit markets that can hedge them from the fluctuation of their income to shocks. In this light, Easterly and Fischer (2001) have shown a strong association between inflation and the well-being of the low-income group, there being a significant negative correlation between the rise of real wages and inflation. Their estimated correlation was obtained from a survey of 31,169 households in thirty-eight countries, controlling for country effects in their panel data. The survey indicated that more poor people ranked inflation as their top national concern than the rich. Easterly and Fisher (2001) have also showed that inflation works as a cruel tax that reduces the relative income of the poor.

While many studies in this area use income data to estimate the well-being of the poor, Meyer and Sulivan (2007) suggest that consumption data would be more appropriate to use. Focusing more on the quality of data for measuring the well-being of the poor, they used the Consumer Expenditure Interview survey (CE), which covers approximately 7,600 respondents. In this survey, respondents reported their expenditure over four consecutive quarters. It was found that consumption inequality increases less than income inequality as shown first by Krueger and Perri in 2006. In this light, a model describing the effect of inflation on the well-being of the poor would be better if it used consumption instead of income as an explanatory variable.

While the impact of macroeconomic policy on poverty remains unclear, the impact of monetary policy on the lower income group is even more so. Seeking to explain the relationship between monetary policy and the well-being of the poor, Romer and Romer (1998) found that the short- and long-term effects of monetary policy on the well-being of the low-income group tend to go in opposite directions. Using U.S. time-series data, they found that expansionary monetary policy benefits the poor in the short run. Cross-sectional analysis of consumption data shows that low inflation and stable aggregate demand are significantly associated with higher well-being of the low-income group. Romer and Romer use two indicators to measure the performance of monetary policy: average inflation and aggregate demand variability. Rather than using the Consumer Price Index (CPI) for inflation, they used average change of logarithm of GDP deflator over a period of twenty years.

They found that income of the low-income group tends to be lower in countries with higher inflation and greater variability of aggregate demand, and higher in the industrialized countries with low variability of aggregate demand. Therefore, they conclude that monetary policy can have a long-run effect on the well-being of the poor.

It is natural to evaluate the performance of central banks in terms of how their monetary policies affect inflation in their respective countries. Recently, the most popular policy for combating inflation has been the Inflation Targeting (IT) framework. There are pros and cons regarding the implementation and effectiveness of IT in general. On one hand, Mishkin (1999, p.595) has observed that “The performance of inflation-targeting regimes has been quite good. Inflation-targeting countries seem to have significantly reduced both the rate of inflation and inflation expectations beyond that which would likely have occurred in the absence of inflation targets.” This testimony provides support for the adoption of an IT framework by central banks in many countries. On the other hand, contrary to Mishkin’s conclusion, Alvaro and Philippe (2006) show, in the context of a time-series model of the U.S. and European Union, that the IT framework has not successfully reduced inflation. Rochon and Rossi (2006) show, moreover, that the adoption of the IT framework tends to worsen income distribution. This exacerbation was perceived through the worsening of wage share after the use of the IT framework as a policy of the central bank. In their research, wage share is measured as the ratio of salaries or wages to employee and GDP at nominal price in the local currency. Despite these negative findings, many economists still believe that the IT framework can successfully reduce the inflation. Mixed findings raise questions, however, as to whether the adoption of IT is necessary and effective for combating inflation and increasing the wealth of the population.

As for the Indonesian case, the IT framework has been adopted officially since 2002, encouraged by the new act of the Central Bank in 1999. While inflation may be the ultimate target of the central bank, in practice, the amount of money in circulation is still important and is mostly perceived as the intermediate target if not the main target of many central banks. The reason for this is that the relationship of money supply and price has a more solid theoretical background than that of IT and price. As Bernanke (1999, p.8) suggests, “To draw a bright line between central banks practicing full-fledged inflation targeting and those firmly outside the inflation targeting camp is more difficult than one might first guess.” This observation has resulted in some unclear distinctions being drawn between those countries which are categorized as IT-adopters and those that are not. As a result, this lack of clarity could generate some bias in empirical analysis regarding the success story of the IT framework. Furthermore, in that same 1999 paper, Bernanke distinguishes between two important uses of the IT framework: 1) as a framework for policy-makers, and 2) as a tool for communicating with the public. In this light, the public‘s confidence of price stability will enable actors in the private sector to better forecast and plan their businesses. Ultimately, the IT framework becomes more like a public announcement of accountability with respect to the main measurable target of the monetary authority.

In Indonesia, the adoption of IT is still relatively recent and has not been fully implemented in practice. Clearly, more research needs to be done regarding the effectiveness of this framework. That being said, this paper will analyze the effects of changes in the money supply on welfare as they are transmitted through the channel of financial services (liquidity). Bank Indonesia (BI), the central bank of Indonesia, is the institution that has the right to conduct monetary policy. Based on the Central Bank Act in 1999, BI has autonomy in conducting monetary policy free from any influence of the government. This act also narrows down the central bank’s scope from many objectives (e.g., growth, employment and prices) to a tight focus on price stability as its only objective.

To study the effect of monetary policy on the welfare levels of different income groups, we examine how changes in the money stock affecting the flow of financial services influence adjustments in income group expenditure shares in a demand system, which in turn are induced by changes in prices and aggregate expenditure levels. Ideally, one would like the system of demand equations to aggregate up consumer behavior exactly and be globally regular. A specific demand function is said to be an exact aggregator if it can represent "market demands as if they were the outcome of decisions [made] by a rational representative consumer." (Deaton and Muelbauer, 1980 p.313). Furthermore, a function is said to be regular if it manifests all the properties stipulated by that specific function according to economic theory (Donaghy and Richard, 1993). There are many types of these demand systems but perhaps the most common ones are AIDS and modified versions of it. Donaghy and Richard (1993 p.230) have argued that "increasing the extent of regularity is more important than preserving exact aggregation," especially when drawing conclusions about the aggregate behavior of people. Considerations of regularity and non-homotheticity lead us to choose a demand system that derives from a utility function that is dual to an MPIGLOG cost function in modeling consumer expenditures of low- and high-income groups in Indonesia.

We model the adjustment of expenditure shares corresponding to an MPIGLOG system by employing a continuous-time version of Anderson and Blundell's (1983) disequilibrium adjustment mechanism. We adopt a disequilibrium adjustment specification because consumers cannot adjust expenditure patterns instantaneously. Anderson and Blundell's adjustment framework specifically allows for adjustments of all expenditures' shares to influence each share. Under the continuous-time specification, adjustment lags that are different from the observational frequency of the data can be estimated (Gandolfo, 1993). Other considerations favoring a continuous-time specification are that 1) differential equation systems are more analytically tractable than difference-equation ones, 2) once estimated, they can be solved or simulated for any time-interval, 3) there is no natural time unit of observation for aggregate behavior, 4) aggregate economic behavior is ongoing, 5) stock and flow variables can be treated correctly, and 6) distributed lag processes can be handled better (Gandolfo, 1993; Bergstrom, 1993; Wymer, 1993b). With the development of the WYSEA software package, and the ESCONA program in particular (Wymer, 2006),[2] and the computational processing capability to implement it, nonlinear dynamic models can now be estimated and simulated in a straightforward manner using continuous-time econometric methods.

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[2] The author is deeply grateful to Prof. Wymer for his permission to use his program, ESCONA, and for his advice and help in coding and running the model to estimate the Indonesian demand system for this study. ESCONA implements the non-linear continuous-time estimator set out in Wymer (1993a).

3.3. Methodology

3.3.1. Model

As noted above, the demand system estimated in this study is derived from the utility function that is dual to an MPIGLOG cost function. As observed by Cooper and McLaren (1993) the MPIGLOG family of cost functions is a generalization of the PIGLOG family developed by Muellbauer (1975) and is an instance of the Gorman polar form (Gorman, 1976), in which preferences are represented as a combination of price aggregator functions. For a utility level *u* and a price vector *p*, the MPIGLOG family of cost functions can be written as

$$\ln C(u,p) = \ln P1 + \frac{uP2}{[C(u,p)]^{\eta}} \qquad (3.3.1.1)$$

in which ln denotes the natural logarithm of a variable, *u* is defined to lie between zero and one, and *P1* and *P2* are price aggregator functions. *P1* is generally assumed to be homogeneous of degree one (HD1) in *p*, and *P2* is homogeneous of degree η (HD η) in *p*. Since Equation (3.3.1.1) is an implicit function, it is easier to discuss the specification in terms of the indirect utility function that is dual to it.

Applying Roy's identity to (3.3.1.2) yields expenditure share equations of the form

$$s_j = [\varepsilon_{1j} + \varepsilon_{2j}\ln(c/P1)]/[1+\eta\ln(c/P1)], \qquad (3.3.1.3)$$

where $s_j = p_j q_j / c, \varepsilon_{1j} = \partial \ln P1/\partial p_j, \sum_j \varepsilon_{1j} = 1.0, \sum_j \varepsilon_{2j} = \eta.$

Defining a weighting expression, $Z = \eta \ln\left(\frac{c}{P1}\right) / \left[1 + \eta \ln\left(\frac{c}{P1}\right)\right]$, the expenditure share equations can be rewritten in terms of Z as

$$s_j = \varepsilon_{1j}(1-Z) + (\varepsilon_{2j}/\eta)Z. \qquad (3.3.1.4)$$

The MPIGLOG demand system (3.3.1.4) will be globally regular when *P*1 is a linearly homogeneous function and *P*2 is Cobb-Douglas, which is the case in this study.

Under Anderson and Blundell's (1983) disequilibrium adjustment mechanism, each household group i is assumed to partially adjust its expenditure shares on commodity group j, s^i_j, to its partial-equilibrium level, s^{ie}_j, where the partial adjustment parameters are denoted using γs. This adjustment process is also influenced by adjustments of all other expenditure shares to their partial-equilibirum levels and the rate of change in aggregate financial services in the economy. Let, Ds^i_j represent the time rate of change in expenditure share *j* by group i. Then the dynamic demand system can be written as (3.3.1.5), in which the time rate of change in financial services (expressed as DFS) influences this adjustment process through the parameter γ_{jf} .

$$Ds^i_j = \sum_{k=1}^{3} \gamma^i_{jk}\left(s^{ie}_k - s^i_k\right) + \gamma_{jf} DFS \qquad (3.3.1.5)$$

The sum of changes in expenditure shares of all commodities for each income group $\sum_{j=1}^{3} Ds^i_j = 0$ should be zero.

The time rate of change in financial service (*DFS*) is determined using Equation (3.3.1.6). The services (contributions to liquidity) of each monetary aggregate are weighted by the ratio of return opportunity of that asset toward the cost of liquidity.

$$DFS = \left(\frac{i_b}{COL}\right).CC.D\ln CC + \left(\frac{i_b - i_{ca}}{COL}\right).CA.D\ln CA + \left(\frac{i_b - i_{qm}}{COL}\right).QM.D\ln QM \qquad (3.3.1.6)$$

The user cost of liquidity (*COL*) specified in Equation (3.3.1.7) follows from the continuous-time version of the Divisia index of monetary aggregates (Barnett et al., 1992; Donaghy and Richard, 1993, 2006) and is also known as the 'Fisher dual price'.

$$COL = i_b.CC + (i_b - i_{ca}).CA + \left(i_b - i_{qm}\right).QM \qquad (3.3.1.7)$$

Here, *CC*, *CA*, *QM*, i_b, and i_{ca} denote currency in circulation, current (checking) accounts, quasi-money, bank lending interest rate and quasi money interest rate respectively.

The use of a Divisia index in computing the services of monetary aggregates has microeconomic foundations in its construction. Since each financial asset provides different monetary services, its weight in the aggregation should be adjusted accordingly. Barnett (1978) introduced the user cost of money as the opportunity cost related to a monetary asset component. In his formulation, the return of each asset is compared with the benchmark return of asset which is assumed to provide no monetary services but only serve as a tool to transfer wealth between the periods with no marginal utility to the user. In its continuous-time case, following Donaghy and Richard (2006), the user cost can be expressed as:

$$\pi_i = p(R - r_i) \qquad (3.3.1.8)$$

Here, subscript i indicates the commodity type, π is the user cost of a monetary asset, p is the user price of that asset, R is the benchmark monetary asset return and r_i is the return of the monetary asset. In our case, the benchmark monetary asset is the average yearly loan rate, i_b, and the user price of each monetary asset is represented by the difference between this rate and the interest rate earned on the stock of that monetary asset. By employing this formulation, one can observe that cash in hand has the highest user-cost of any monetary asset.

In the case of Indonesia, the money supply can be categorized broadly into three categories: the base money, money supply narrowly defined (*M1*) and money supply broadly defined (*M2*). The base money consists of currency in circulation (*CC*) which is the currency held by the people outside of the banking system. Narrowly defined money supply consists of currency in circulation and the current accounts owned by those other than banks in the banking system, including in those the central bank. Broadly defined, money supply is the narrowly defined money supply and the quasi money owned by parties other than banks. All kinds of deposits owned by private domestic institutions including individuals which can be drawn on at any time and be exchanged with currency as much as their values are included in the current account money statistics. All other kinds of deposit owned by private domestics and temporarily lose their function as medium of exchange but have other functions of money (e.g., store of wealth, deferred payments, and counting unit tools) are included in quasi money statistics.

Though, the money supply is officially no longer used as the official target of the central bank, in practice, the monetary authorities still monitor the amount of the money supply very closely in comparison with its unofficial targeted amount to ensure that it falls within the intended benchmark range. The reaction function of the monetary authorities should reflect an adjustment in the rate of growth of the money supply to some set of conditions that *together* represent an equilibrium growth rate. Only in the period since 1988, have the financial sectors developed quickly enough to include a shift of the target of the central bank in 2002 from a money stock target to an inflation target. In day-to-day operation, however, the money supply target is still used as an intermediate target, especially in open market operations conducted by the central bank through its decision on the interest rates of its bonds.

Suppose the central bank has a target for the rate of growth of the money stock, λ, that may differ from the rate of growth of nominal GDP ($D \ln P + D \ln Y$). Also, suppose that authorities acknowledge that the money stock in circulation should grow in step with transactions demand for money – i.e., $D \ln P + D \ln Y$ – but that the capital investment-related demand for money will be inversely related to the long-term borrowing rate, r. Then a first pass at a set of equations characterizing authorities' adjustment of the money supply might be represented by the following equation:

$$Dm = \gamma\{\lambda + \beta_1(D \ln P + D \ln Y) - \beta_2 r - m\}, \qquad (3.3.1.9)$$

where $D \ln M = m$

In Equation (3.3.1.9), the parameter γ represents an elasticity of response. When this reaction function has been estimated, it can be used to conduct simulations to examine the impact of variations in liquidity on the welfare of different income classes induced by different targeted levels of growth, λ. We would expect different income groups to respond differently to different targets of growth in the money supply.

Each income group reacts to the increase or decrease in financial services by either increasing or decreasing of their consumption in the different expenditure categories. Rates of change in expenditure shares depend on the time rate of change in financial services, which in turn is a function of the money in circulation. We use the stock of currency as the money stock in this equation. The rates of change in expenditure shares are captured by Equation (T3.3.1.2.5) in Table (3.3.1.1). Once all of the parameters have been estimated, the welfare of each income group can be computed using Equation (T3.3.1.2.8). Following Donaghy and Richard (2006, p.83), we can also compute the expenditure elasticities of demand and price elasticities of demand for each income group and each commodity. The expenditure and price elasticities of demand are computed using Equations (T3.3.1.1.9) and (T3.3.1.1.10) respectively. The cross-price elasticities of demand for commodity j for the change of the commodity price *k* of the income group *i* are derived from the following equation (Donaghy and Richard, 2006, Eq. 4.10, p.83):

$$M_{jk}^{i} = \frac{\varepsilon_{1jk}^{i}\left(1-Z^{i}\right)+\left(\varepsilon_{2jk}^{i}/\eta^{i}\right)Z^{i}-\phi_{j}^{i}\beta_{k}^{i}\left(1-Z^{i}\right)}{s_{j}^{i}-\delta_{jk}+\eta^{i}\phi_{j}^{i}\left(1-Z^{i}\right)} \qquad (3.3.1.10)$$

where ε_{1jk}^{i} and ε_{2jk}^{i} are the cross elasticities of the price aggregators $P1$ and $P2$ with respect to two commodity prices p_j and p_k.The symbol δ_{jk} is the Kronecker delta which has the value of 0 if $j \neq k$ and 1 if $j = k$. Since $P1$ is a CES function and $P2$ is a Cobb-Douglas function, they can be simply written as:

$$\varepsilon_{1jk}^{i} = \frac{\partial^2 \ln P1}{\partial \ln p_j \partial \ln p_k} = \phi_j^i \phi_k^i \rho^i Z^{i^{\frac{1}{\rho^i}-2}} p_j^{-\rho^i} p_k^{-\rho^i} \qquad (3.3.1.11)$$

$$\varepsilon_{2jk}^{i} = \frac{\partial^2 \ln P2}{\partial \ln p_j \partial \ln p_k} = 0$$

The first derivative of the logarithm of the price aggregator $P2$ with respect to the logarithm of the commodity price p_j results in a share parameter which is a constant. Then, it follows that the second derivative of that will just be zero. Therefore, Equation (3.3.1.10) can be simplified into Equation (T3.3.1.1.10).

The elements of the Slutsky matrix are the result of the decomposition of the effects of price changes on Marshallian demand into two components – namely, substitution effect and income effect. The substitution effect represents the change of the Hicksian demand with respect to price, and the income effect represents the product of the change of the income with respect to income changes and the income level.[3] The elements of the Slutsky matrix of our MPIGLOG demand system can be easily computed using the following equation:

$$S_{jk}^{i} = \frac{c^{i}}{p_j p_k}\left[s_{jk}^{i} M_{jk}^{i} + s_j^{i} s_k^{i} E_j^{i}\right] \tag{3.3.1.12}$$

We close the model by endogenizing rates of change in the aggregate expenditure levels of the income groups in terms of rates of change in nominal GDP and the money supply as in Equation (T3.3.1.1.7).

[3]We can state the change of the Marshallian demand with respect to price as the summation of the change of the Marshallian demand with respect to price and the change of the demand with respect to income change:

$q_j^M(p,y) \equiv q_j^H(p,u) = q_j^M(p,c(p,u)) \equiv q_j^H(p,u)$

Taking the total derivative w.r.t. price, we would have $\frac{\partial q_j^M}{\partial p} + \frac{\partial q_j^M}{\partial y}\frac{\partial c}{\partial p} = \frac{\partial q_j^H}{\partial p}$ and rearrange it tohave:

$\frac{\partial q_j^M}{\partial p} = \frac{\partial q_j^H}{\partial p} - \frac{\partial q_j^M}{\partial y}\frac{\partial c}{\partial p} = \frac{\partial q_j^H}{\partial p} - \frac{\partial q_j^M}{\partial y} y$

While data for the financial and monetary sectors are abundantly available, data for the expenditure shares to be used in Equation (3.3.1.5) are more limited. For this reason, then, the scope of our ambition in modeling economy-wide behavior is limited. Table (3.3.1.1) shows the final list of equations used in our simple model.

Table 3.3.1.1: Model Equations

Equations	**Eq. Number**
Price aggregator equation: $P1^i = \left(\sum_j \phi_j^i p_j^{-\rho^i}\right)^{-1/\rho^i}$ $P2^i = \prod_j p_j^{\beta_j^i}$	T3.3.1.1.1.
$Z^i = \dfrac{\eta^i ln\left(\frac{c^i}{p_1^{*i}}\right)}{\left[1 + \eta^i ln\left(\frac{c^i}{p_1^{*i}}\right)\right]}$	T3.3.1.1.2.
Equilibrium shares of consumption: $s_j^{ie} = \phi_j^i \left(\frac{p_1^{*i}}{p_j}\right)^{\rho^i} \left(1 - Z^i\right) + \left(\frac{\beta_j^i}{\eta^i}\right) Z^i$ With $\phi_j^i \geq 0, \beta_j^i \geq 0$ and $\eta^i = \sum_j \beta_j^i$	T3.3.1.1.3.

Time rate of change in financial services: $DFS = \left(\frac{i_b}{COL}\right).CC.D\ln CC + \left(\frac{i_b - i_{ca}}{COL}\right).CA.D\ln CA + \left(\frac{i_b - i_{qm}}{COL}\right).QM.D\ln QM$ With cost of liquidity (COL): $COL = i_b.CC + (i_b - i_{ca}).CA + \left(i_b - i_{qm}\right).QM$	T3.3.1.1.4
Time rates of change in expenditure shares of each income group: $Ds_j^i = \sum_{k=1}^{3} \gamma_{jk}^i \left(s_k^{ie} - s_k^i\right) + \gamma_{jf}^i DFS$ for all $j = 1,2,3$ With $\sum_j Ds_j^i = 0$.	T3.3.1.1.5.
Time rate of change in the growth rate of the money supply: $Dm = \gamma_6\{\lambda + \beta_1(D\ln P + D\ln Y) - \beta_2 r - m\}$ with $D\ln M = m$	T3.3.1.1.6.
Percentage rate of changes in aggregate expenditure of each income group: $D\ln c^i = \beta_3^i(D\ln P + D\ln Y) + \beta_4^i D\ln M$	T3.3.1.1.7.
Utility of each income group: $U\left(c^i, p\right) = [\ln(c^i/P1^{*i})]\left[c^i/P2^i\right]$	T3.3.1.1.8

Expenditure elasticities of demand for good j by income group i: $E_j^i = 1 + \left(\frac{\beta_j^i}{s_j^i - \eta^i}\right)(1 - Z^i)$	T3.3.1.1.9
Price elasticities of demand for good j with respect to price change k of income group i: $M_{jk}^i = \frac{\varepsilon_{1jk}^i(1-Z^i) - \phi_j^i \beta_k^i (1-Z^i)}{s_j^i - \delta_{jk} + \eta^i \phi_j^i (1-Z^i)}$ With: $\varepsilon_{1jk}^i = \phi_j^i \phi_k^i \rho^i {Z^i}^{\frac{1}{\rho^i}-2} p_j^{-\rho^i} p_k^{-\rho^i}$	T3.3.1.1.10

Table 3.3.1.2: Definition of Parameters

Parameters	**Definitions of Parameters**
ρ^i	Parameter of substitution of income group i
ϕ_j^i	Share parameter of j^{th} commodity price with i^{th} income group.
β_j^i	The contribution of j^{th} commodity toward parameter η for each income group.
η^i	The degree of homogeneity of the price aggregator of the i^{th} income group.
γ_{jk}^i	Parameter of adjustment of j^{th}commodity related to k^{th}commodity for i^{th} income group.

γ_{jf}^{i}	Parameter of adjustment of j^{th}commodity related to the financial services for i^{th} income group.
γ_6	Parameter of adjustment for the money supply
β_1	Parameter of adjustment of the real GDP
β_2	Parameter of the benchmark interest rates.
p_j	Price of j^{th}commodity
s_k^i	Share of k^{th}commodity toward the consumption of the i^{th} income group.
CC	Currency in circulation
CA	Current account (checking accounts)
QM	Quasi money (savings accounts)
i_b	Benchmark interest rates, here is loan interest rates
i_{ca}	Current account interest rates, we use BI rates
i_{qm}	Savings interest rates, we use the average savings rates
P	GDP deflators
Y	Real GDP in constant rupiahs.
c^i	Consumption by income group i
E_j^i	Expenditure elasticities of demand of income group i
M_{jk}^i	Price elasticities of demand for commodity j of income group i by the change of the price p_k.

3.3.2. Data Processing

Data for this study were gathered from several sources, but the two main sources were BPS (Indonesian Statistics Bureau) and BI (Indonesian Central Bank) both of which collected annual observations from 1974 to 2011. The data on consumption shares were taken from Indonesian household surveys (Socio-economic Survey or SUSENAS). Though the surveys collect people's characteristics such as health/nutrition, housing/environment, criminality, socio-cultural activities, consumption and income from around 60,000 samples, we only used survey data regarding consumption shares of certain commodities. Consumption share data are available on a tri-annual basis from 1974 until 2001 and annually from 2002 onwards.

Price data were taken from consumer price reports that are published on a monthly basis. We used the yearly inflation based on the end of the year comparisons. All of the output data were taken from GDP reports, which have been published every quarter since 1993. All other data were taken from Bank Indonesia publications (for monetary data) or the online sources EIU and CEIC (for interest rate data).

The two household groups represented in this study are divided according to a 65:35 ratio of population based on nominal expenditures in each particular year. In this ratio, the first number indicates the nominal expenditures of the 65% of the total population with the lowest incomes, while the latter number indicates the nominal expenditures of the 35% of the total population with the highest incomes. A least squares regression representing the quadratic approximation is used to estimate the expenditure share of the expenditure bracket toward the threshold of 65%, which is then categorized as the low-income group. The remaining 35% is then categorized as the high-income group. We estimated the nominal expenditures on three kinds of goods – i.e., food, housing and other – for the low- and high-income groups. If x denotes the cumulative population and y denotes the nominal consumption, then we need to estimate the parameters of the following quadratic equation:

$$y = \beta_0 + \beta_1 x + \beta_2 x^2 \qquad (3.3.2.1)$$

The estimated parameters obtained as a result of a simple OLS regression, then together with cumulative population data $x's$, are used to estimate nominal consumption at 65% cumulative population for all data during the period of 1984 to 2011:

$$\widehat{y_{65}} = \beta_0 + \beta_1 x_{65} + \beta_2 x_{65}^2 \qquad (3.3.2.2)$$

The data shares of each household group that resulted from this 65:35 ratio have the period of a three-year span between 1974 and 2000 except in 1998 data which was published due to the financial crisis 1997. For this reason, we need to interpolate between the years in that period. The interpolation method that we used was the Catmul-Rom Splines interpolation (Catmul, E. and Rom, R., 1974). Catmul-Rom Splines Interpolation is an interpolation within the family of cubic interpolation:

$$p(x) = c_0 + c_1 x + c_2 x^2 + c_3 x^3, \qquad (3.3.2.3)$$

where $c's$ are parameters of the cubic function that are estimated by the available data. Following closely the procedure outlined in Twigg (2003), which was based on Catmul and Rom (1974), we can interpolate a value of the variable of interest if we are given five consecutive points: p_0, p_1, p_2, p_3, p_4 with a tangent at p_1 that is denoted by $g(p_1) = \gamma(p_2 - p_0)$, where γ is a parameter of the cubic function that determines the curve of the interpolated points. When we focus our interest on points p_{i-1}, p_i, then we have the following:

$$p(0) = c_0$$

$$p(1) = c_0 + c_1 + c_2 + c_3$$

$$p'(0) = g\big(p(0)\big) = c_1$$

$$p'(1) = g\big(p(1)\big) = c_1 + 2c_2 + 3c_3 \qquad (3.3.2.4)$$

We also know that:

$$p(0) = p_{i-1}$$

$$p(1) = p_i$$

$$p'(0) = \gamma(p_i - p_{i-2})$$

$$p'(1) = \gamma(p_{i+1} - p_{i-1}) \qquad (3.3.2.5)$$

Then, the parameters can be determined by combining equations (3.3.2.4) and (3.3.2.5) and solving for $c's$ to obtain the following:

$$c_0 = p_{i-1}$$

$$c_1 = -\gamma p_{i-2} + \gamma p_i$$

$$c_2 = 2\gamma p_{i-2} + (\gamma - 3)p_{i-1} + (3 - 2\gamma)p_i - \gamma p_{i+1}$$

$$c_3 = -\gamma p_{i-2} + (2 - \gamma)p_{i-1} + (\gamma - 2)p_i + \gamma p_{i+1} \qquad (3.3.2.6)$$

In the Indonesian case, we select the value of $\gamma = 0.5$, which is commonly used for this kind of interpolation. We can then compute the interpolated points by using the following matrix equation:

$$p(s) = [1 \quad x \quad x^2 \quad x^3]\begin{bmatrix} 0 & 1 & 0 & 0 \\ -\gamma & 0 & \gamma & 0 \\ 2\gamma & (\gamma - 3) & (3 - 2\gamma) & -\gamma \\ -\gamma & (2 - \gamma) & (\gamma - 2) & \gamma \end{bmatrix}\begin{bmatrix} p_{i-2} \\ p_{i-1} \\ p_i \\ p_{i+1} \end{bmatrix} \qquad (3.3.2.7)$$

When transforming a three-year data period into yearly data with each row associated with different x's according to $x = \{x_1, x_2, x_3) = \{0.333, 0.67, 1\}$, we will have the matrix M which is just the multiplication of the first two matrices in (3.3.2.7).

$$M = \begin{bmatrix} -0.5x_1^3 + x_1^2 - 0.5x_1 & 1.5x^3 - 2.5x^2 + 1 & -1.5x^3 + 2x^2 + 0.5x & 0.5x^3 - 0.5x^2 \\ -0.5x^3 + x^2 - 0.5x & 1.5x^3 - 2.5x^2 + 1 & -1.5x^3 + 2x^2 + 0.5x & 0.5x^3 - 0.5x^2 \\ -0.5x^3 + x^2 - 0.5x & 1.5x^3 - 2.5x^2 + 1 & -1.5x^3 + 2x^2 + 0.5x & 0.5x^3 - 0.5x^2 \end{bmatrix} \tag{3.3.2.8}$$

It should be noted that, in order to be complete, the interpolation requires that the first and last data points be guessed. The interpolated points will start from the fifth interpolated data point and end at the $n - 2$ interpolated data point. So, for the three-year data period from 1984 to 2000, we need data ranging from 1981 to 2002 in order to interpolate data points from 1984 to 2000. This enables us to estimate the adjustment share parameters of the demand function of different income groups based on yearly data.

3.4. Results

Estimating the model by a quasi-Newton maximum-likelihood method, yielded parameter estimates as reported in Table (3.4.1). The statistical discernability of all results is considered at a 0.05 level of statistical significance. The estimation algorithm reached convergence when using the base step-length of 4.69e-6 with the optimized step-length of 2.85e-6. A maximum log-likelihood function value of 650.3 was attained after 107 iterations.

The values of η_l and η_u in Equations (T3.3.1.1.3), which are the summation of $\beta_l^f, \beta_l^h, \beta_l^o$ and $\beta_u^f, \beta_u^h, \beta_u^o$, respectively, are estimated and have statistically discernible values, as can be seen in Table (3.4.1). The estimated values of $\phi_l^f, \phi_l^h, \phi_l^o$ and $\phi_u^f, \phi_u^h, \phi_u^o$ can also be seen in Table (3.4.1). The effect of the price index toward food consumption with respect to its total shares is greater for the lower-income group than for the higher-income group; however, with respect to housing and other commodities, the effects of the price index are lower for the low-income group than for the high-income group. Also as expected, the contribution of the real consumption of food by the low-income group to the food share equilibrium is bigger than that of housing and other commodities; however, this is not the case for the high-income group.

Table 3.4.1: Estimation of Parameters

Parameters	Values	Std. Errors	t-values
ρ_l	0.4423	0.0903	4.90
ρ_u	0.1546	0.0823	1.88
ϵ_l	0.3002	0.0017	178.88
ϵ_u	0.6887	0.0713	9.66
β_l^f	0.2724	0.0106	25.61
β_l^h	0.0092	0.0111	0.83
β_l^o	0.0186	0.0021	8.83
β_u^f	0.2486	0.0197	12.60
β_u^h	0.1210	0.0176	6.87
β_u^o	0.3191	0.0468	6.83
ϕ_l^f	0.3287	0.0338	9.73
ϕ_l^h	0.2109	0.0223	9.44
ϕ_l^o	0.0987	0.0002	651.79
ϕ_u^f	0.5650	0.0981	5.76
ϕ_u^h	0.2103	0.0177	11.88
ϕ_u^o	0.4786	0.0241	19.85

The result of our Equations (T3.3.1.1.3) and (T3.3.1.1.4) can be seen in Table (3.4.2), which represents the estimated forms of the Equations (3.4.1) and (3.4.2).

$$\widehat{Ds_f^l} = \gamma_{11}\left(s_f^{le} - s_f^l\right) + \gamma_{12}\left(s_h^{le} - s_h^l\right) + \gamma_{13}(s_o^{le} - s_o^l) + \gamma_{14}DFS$$

$$\widehat{Ds_h^l} = \gamma_{21}\left(s_f^{le} - s_f^l\right) + \gamma_{22}\left(s_h^{le} - s_h^l\right) + \gamma_{23}(s_o^{le} - s_o^l) + \gamma_{24}DFS$$

$$\widehat{Ds_f^u} = \gamma_{41}\left(s_f^{ue} - s_f^u\right) + \gamma_{42}(s_h^{ue} - s_h^u) + \gamma_{43}(s_o^{ue} - s_o^u) + \gamma_{44}DFS$$

$$\widehat{Ds_h^u} = \gamma_{51}\left(s_f^{ue} - s_f^u\right) + \gamma_{52}(s_h^{ue} - s_h^u) + \gamma_{53}(s_o^{ue} - s_o^u) + \gamma_{54}DFS$$

$$\widehat{Ds_o^l} = -\widehat{Ds_f^l} - \widehat{Ds_h^l}$$

$$\widehat{Ds_o^u} = -\widehat{Ds_f^u} - \widehat{Ds_h^u} \qquad (3.4.1)$$

$$\widehat{Dm} = \gamma_6[\gimel + \beta_1(D\ln P + D\ln Y) - \beta_2 r - m] \qquad (3.4.2)$$

where $\widehat{D\ln M} = m$

As one would expect, estimates of the parameters, γ_{11}, γ_{22}, γ_{41}, γ_{52}, which represent rates of own partial adjustment of commodity consumption shares, are positive and are significantly discernible from zero. These positive values indicate that the adjustment of the expenditure share of a commodity is in the same direction of the change toward the equilibrium from its disequilibrium position of that commodity.

As is evident in Table (3.4.2), both income groups adjust their expenditure shares in the same manner. When the share of the other consumption falls (increases), then the food expenditure adjustment would increase (decrease). Though, the relative magnitude of the adjustment of food expenditure shares seems to be bigger for the low-income group than for the high-income group. The cross-expenditure adjustments toward food consumption shares are positive for all income groups.

The estimates of parameters for housing consumption shares seem to be of the same signs for both income groups. The cross-adjustment from the disequilibrium of food and other shares contributes negatively to the adjustment of housing consumption shares. This means that, for both income groups, housing consumption is not a priority to adjust before food and other commodities.

The financial service contributions toward the expenditure adjustments are mostly positive and significant for all commodities except for housing expenditure for the low-income group which has a negative but significant effect. For the high-income group, as indicated by the positive significant values, the increase in the financial service would also contribute to a higher proportion of housing expenditure. This is not the case for the low-income group which tends to reduce the proportion of the housing expenditure when there is an increase in the financial service. The increase of the financial services in general increases the speed of adjustment to the equilibrium level for food and other commodities.

The estimates of γ_6 have positive and significantly discernible values, which indicates that the increase (decrease) of the monetary target (λ), the growth of the nominal GDP, and the decrease (increase) of the interest rates would lead the Bank to accelerate (decelerate) the money supply growth. The parameters $\lambda, \beta_1, \text{and}\ \beta_2$ are positive and significant, which respectively indicate that the money supply would react positively to an increase of the money supply target (λ), the growth increase of the nominal GDP (β_1), and the decrease of the interest rates (β_2). The parameters of the growth of the nominal GDP (β_{3l}, β_{3u}) and the money cash (β_{4l}, β_{4u}) for both income groups are positive and significant except for parameter β_{3l}.

Table 3.4.2: Estimates of Parameters in Equations (T3.3.1.1.5) and (T3.3.1.1.6)

Parameters	Values	Std. Errors	t-values
γ_{11}	0.3002	0.0255	11.79
γ_{12}	0.1257	0.0165	7.64
γ_{13}	0.0743	0.0075	9.97
γ_{14}	0.1286	0.0057	22.45
γ_{21}	-0.0005	0.0105	0.04
γ_{22}	0.0995	0.0004	272.84
γ_{23}	-0.0215	0.0110	1.95
γ_{24}	-0.0743	0.0029	25.76
γ_{41}	0.2667	0.0070	38.15
γ_{42}	0.2410	0.0118	20.49
γ_{43}	0.0925	0.0016	59.42
γ_{44}	0.1706	0.0046	37.16
γ_{51}	-0.0341	0.0126	2.70
γ_{52}	0.1771	0.0064	27.53
γ_{53}	-0.0108	0.0185	0.58
γ_{54}	0.0971	0.0007	133.31
γ_{6}	0.0308	0.0047	6.56
β_{1}	0.2459	0.0234	10.49
β_{2}	0.0954	0.0070	13.64
β_{3l}	0.0185	0.0139	1.33
β_{4l}	0.2058	0.0125	16.45
β_{3u}	0.1065	0.0009	118.25
β_{4u}	0.0968	0.0013	76.33
λ	0.9506	0.0358	26.55

In Figures 3.4.1 – 3.4.4, we can see the in-period model solution values and the observed values, respectively, for food consumption shares (Fig. 3.4.1), household consumptions shares (Fig. 3.4.2) and other consumption shares (Fig. 3.4.3) by all types of income groups, as well as changes of the monetary growth (Fig. 3.4.4). With the exception of the changes of the monetary growth, all figures of consumption shares exhibit increasing fluctuation after the 1997/1998 financial crisis.

Figure 3.4.1: Comparison of Observed and Estimated Food Expenditure Shares

Figure 3.4.2: Comparison of Observed and Estimated Housing Expenditure Shares

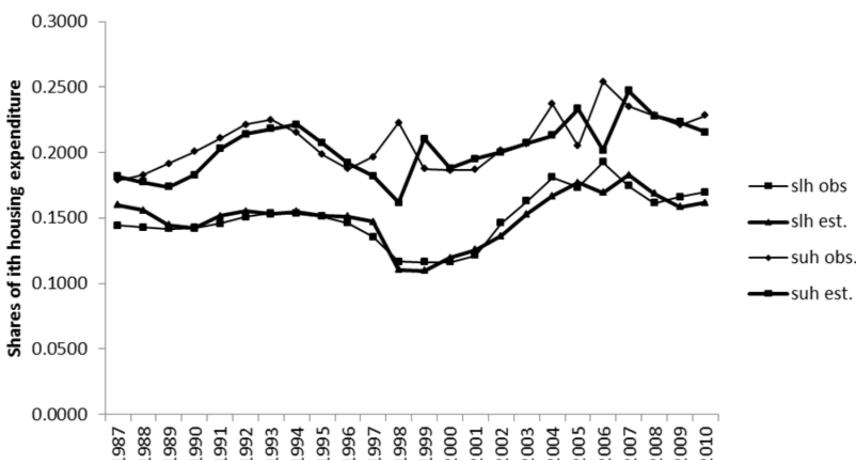


Figure 3.4.3: Comparison of Observed and Estimated Other Commodity Expenditure Shares

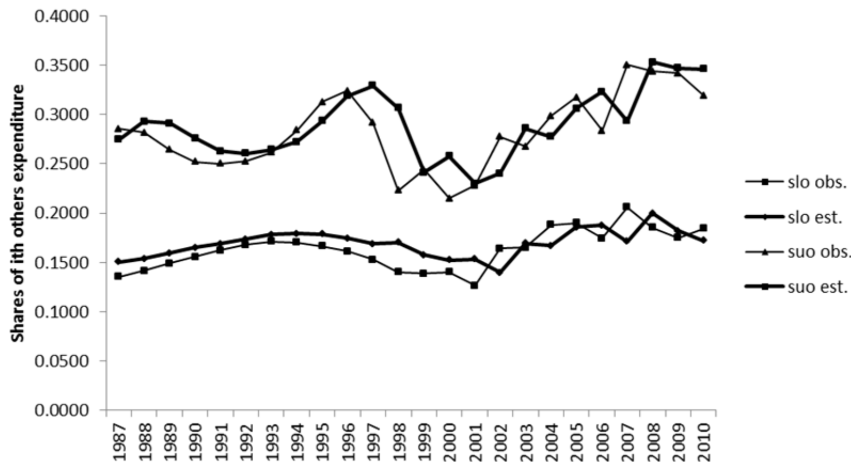
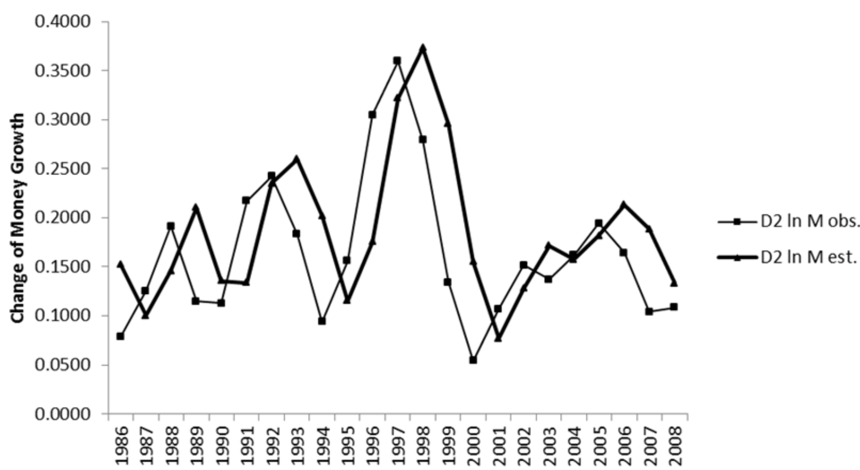


Figure 3.4.4: Comparison of Observed and Estimated Money Growth Changes



The results of some simulations conducted by changing the targeted rate of monetary growth λ are given in Table (3.4.3), which exhibits the estimates of food (*slf* and *suf*) and housing (*slh* and *suh*) consumption shares by low- and high-income groups as well as the changes in the rate of growth of the stock of money (*cc1*) ranging from $\lambda = 0.45$ to $\lambda = 4.95$. These values were chosen bearing in mind the value of the product of estimation of γ_6 and λ.

With respect to food consumption shares, the increase of the monetary targets increases the food consumption shares of all income groups (Fig. 3.4.5). As expected too, the food consumption shares of the low-income group are higher than those of the high-income group. With respect to the housing consumption shares, the increase of the monetary targets has an opposite households' reactions. The low-income groups would increase their housing consumption shares while the high-income groups would reduce theirs (Fig. 3.4.6). Next, in Figure 3.4.7, with respect to other commodities, both income groups react negatively toward the increase of the monetary targets, by reducing their consumption shares of other commodities.

Lastly, Figure 3.4.8 reveals that the monetary policy changes affect the low-income group more than they affect the high-income group. The percentage changes of the utility level of the low-income group are higher than those of the high-income group at every change of the monetary policy, which is represented here by the currency in circulation.

Employing the identity equation as in Equations (T3.3.1.1.9) and (T3.3.1.1.10) to compute the expenditure and the price elasticities of demand, respectively, we have the following results (Tables 3.4.4 and 3.4.5). Table 3.4.4 shows that as the level of expenditure increases (decreases), those in the low-income group will increase (decrease) their food expenditure more than those in the high-income group. For the housing and other commodities expenditures, both income groups don't reveal big differences in their expenditure elasticities of demand. Table 3.4.5 shows that all own-price elasticities of demand of both income groups have negative values with the own food price elasticity of the low-income groups is higher than that of the high-income group.[4] Though the price elasticities of housing demand are relatively inelastic, the high-income groups have more flexibility and thus tend to be more elastic than those of the low-income groups. The higher price elasticities of demand for the high-income groups are also applied for other commodities which in this case the low income groups have relatively inelastic demand while the high-income groups have relatively elastic demand.

Table 3.4.5 also reveals that the cross-price elasticities of demand for all commodity groups exhibit positive values and thus inhibit substitution effects between commodities. The food demand by the low-income group with respect to the changes of housing and other prices are again relatively inelastic, whereas it is relatively elastic for the high-income groups when deals with the change of others prices. For the price elasticities of the housing demand, the low-income groups are more elastic than the high-income groups. This implies that expenditures on housing are not the main priority of the low-income group and are very much dependent upon other commodity prices.

Regarding the changes of expenditure elasticities over time, as can be seen from Figures 3.4.9 and 3.4.10, the expenditure elasticities of food and housing, respectively,

[4] If $M_{ij} < 1$ the demand of good i by the change of the commodity price p_j is inelastic; and when $M_{ij} > 1$, the price elasticity of the demand is elastic. If $M_{ij} = 1$, the price elasticity of the demand is unitary elastic.

show different trends for high- and low-income people. Low-income people are more responsive to price changes than high-income people, and their food expenditure elasticities are relatively stable. On the other hand, though the high-income group's food expenditure elasticities are more inelastic than those of the low-income group, they tend to become more elastic over time. This can be understood as the more globalized world has induced even more high-income people to look at the relative prices among goods that they consume as more choices are available to them. Regarding the housing expenditure elasticities, both groups show an increasing trend with the housing expenditure elasticity of the low-income group consistently being higher than that of the high-income group.

Now, let us briefly examine the trends of the price elasticities over time. As can be seen from Figures 3.4.11 and 3.4.12, the own-price elasticity of demand for food and housing, respectively, for both income groups show the same decreasing trend (in absolute values). Furthermore, as can be seen from Figure 3.4.13, the cross-price elasticities of demand for food with respect to the price of housing show the same decreasing trends for both income groups. This trend can also be observed for the cross-price elasticities of demand for housing with respect to price of food (Fig. 3.4.14). This pattern might simply reflect the availability of more choices for consumption in each commodity group, so that even when the price of food (housing) increases, people would still be able to consume food (housing) though in different kinds and qualities. It follows that the cross-price elasticities would become increasingly inelastic with respect to the commodity groups; however, this might not be the case with individual commodities.

One might inquire, how about the effects of the change of the monetary policy toward the expenditure and price elasticities? Changes of monetary policy affect expenditure elasticity and price elasticity differently for households of the different income groups. As more (less) cash is available, the food expenditure elasticities of both income groups tend to decrease (increase) as can be seen in Figure 3.4.15. This finding is in line with the marginal utility of consuming one good that is increasing at a decreasing rate. Meanwhile, Figure 3.4.16 reveals that the own-price elasticity of demand for housing for the low-income group tends to increase (decrease) as more (less) cash becomes available. This trend is opposite to that of the high-income group, which would decline (increase) as more (less) cash becomes available.

Figures 3.4.17 and 3.4.18 show how the cross-price elasticities of food and housing demand vary with respect to the changes of housing and others prices respectively. As can be seen in Figure 3.4.17, both income groups react similarly in that they reduce (increase) food consumption as a result of the changes in the housing price when the monetary policy increases (decreases) the money stock. Figure 3.4.18 shows a different trend of cross-price elasticities of the housing demand as the other commodity prices change in response to the monetary policy changes. The cross-price elasticities of demand for housing with respect to other prices of the low-income groups tend to increase (decrease) as more (less) cash becomes available. On the other hand, the cross-price elasticities of the high-income groups tend to reduce (increase) as more (less) cash becomes available.

The complete results of the effects of the changes of the monetary policy on expenditure and price elasticities of demand can be seen in Appendices 3A and 3B, respectively.

Table 3.4.3: Endogenous Variables Estimation and Targeted Rates of Growth of the Money Stock (λs)

Variables	Estimated									
λ =	0.4506	0.9506	1.4506	1.9506	2.4506	2.9506	3.4506	3.9506	4.4506	4.9506
slf	0.6728	0.6758	0.6748	0.6754	0.6769	0.6764	0.6762	0.6775	0.6794	0.6785
	0.6728	0.6758	0.6748	0.6754	0.6769	0.6764	0.6762	0.6775	0.6794	0.6785
slh	0.1563	0.1545	0.1551	0.1548	0.1539	0.1542	0.1543	0.1535	0.1523	0.1529
	0.1563	0.1545	0.1551	0.1548	0.1539	0.1542	0.1543	0.1535	0.1523	0.1529
suf	0.5127	0.5165	0.5152	0.5159	0.5178	0.5172	0.5170	0.5186	0.5210	0.5199
	0.5127	0.5165	0.5152	0.5159	0.5178	0.5172	0.5170	0.5186	0.5210	0.5199
suh	0.2177	0.2200	0.2193	0.2197	0.2208	0.2204	0.2203	0.2213	0.2227	0.2220
	0.2177	0.2200	0.2193	0.2197	0.2208	0.2204	0.2203	0.2213	0.2227	0.2220
cc1	0.1681	0.1757	0.1833	0.1909	0.1985	0.2063	0.2137	0.2214	0.2290	0.2366
	0.1681	0.1757	0.1833	0.1909	0.1985	0.2063	0.2137	0.2214	0.2290	0.2366

Table 3.4.4: Expenditure Elasticities of Demand for Different Commodities by Different Income Groups

	Type of Households	
Commodities	Low-Income	High-Income
Food expenditure	1.8045	0.5201
Housing expenditure	0.9292	0.9204
Others expenditure	0.8416	0.7678

Computed by the author

Table 3.4.5: Price Elasticities of Demand for Different Commodities by Different Income Groups

	Type of Households	
Commodities	Low-Income	High-Income
Food - price of food	-5.286100	-2.933375
Food - price of housing	0.860205	0.622748
Food - price of others	0.468892	1.326905
Housing - price of food	2.606485	1.038709
Housing - price of housing	-0.593384	-0.179992
Housing - price of others	1.228677	0.961760
Others - price of food	1.254140	2.201273
Others - price of housing	0.942039	1.043369
Others - price of others	-0.231077	-1.137441

Computed by the author

Figure 3.4.5: Simulations with Different Targeted Rates of Growth (TROG) of the Money Stock (λs) for Expenditure Share of Food toward Different Income Groups

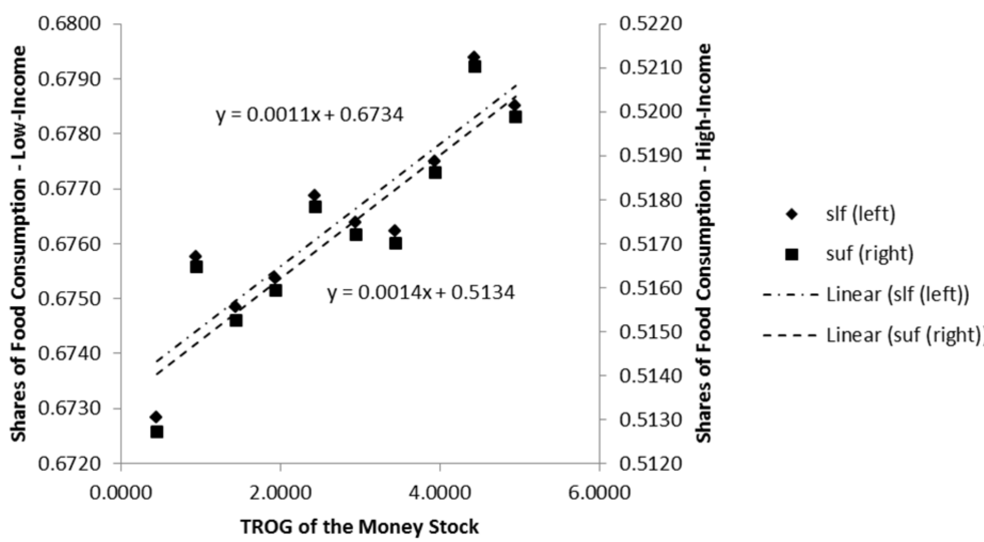


Figure 3.4.6: Simulations with Different TROG of the Money Stock (λs) for Expenditure Share of Housing toward Different Income Groups

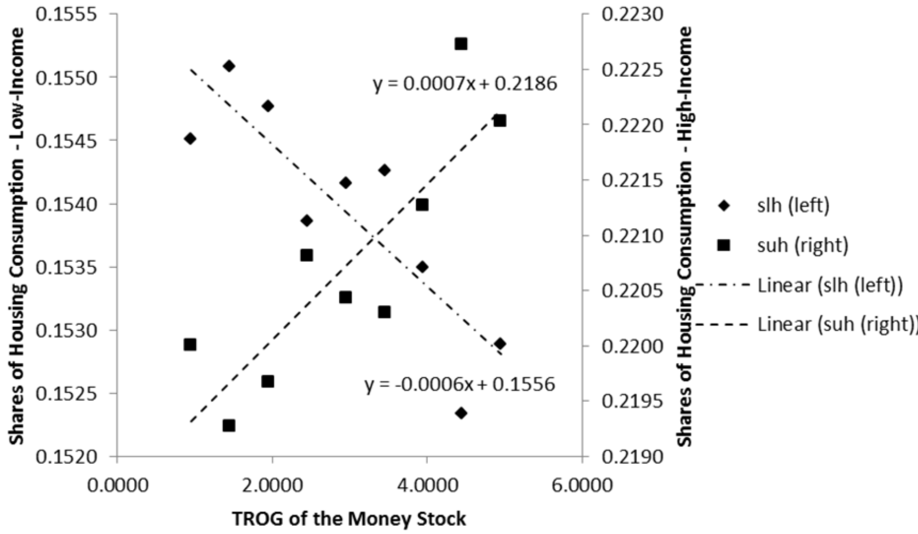


Figure 3.4.7: Simulations with Different TROG of the Money Stock (λs) for Expenditure Share of Other Commodities toward Different Income Groups

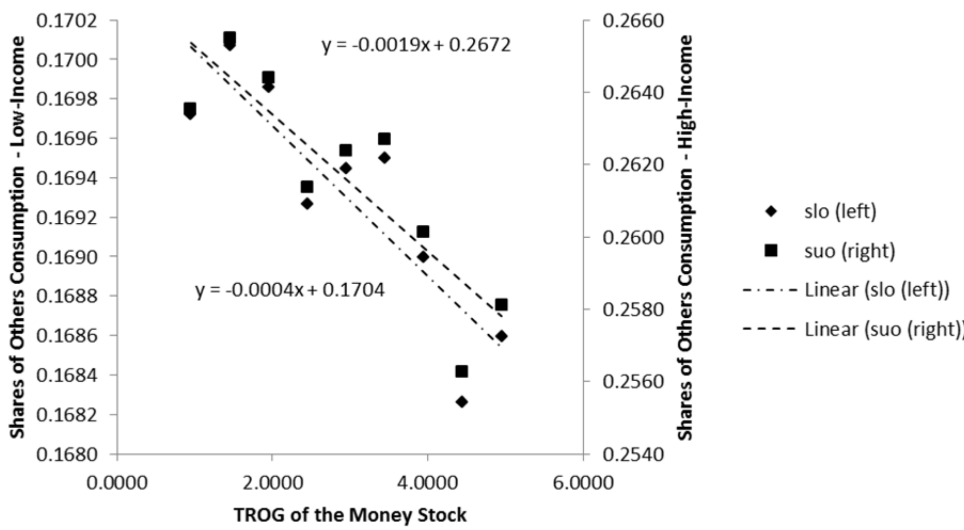


Figure 3.4.8: Changes in Utility by Income Groups for Alternative TROG of the Money Stock (λs)

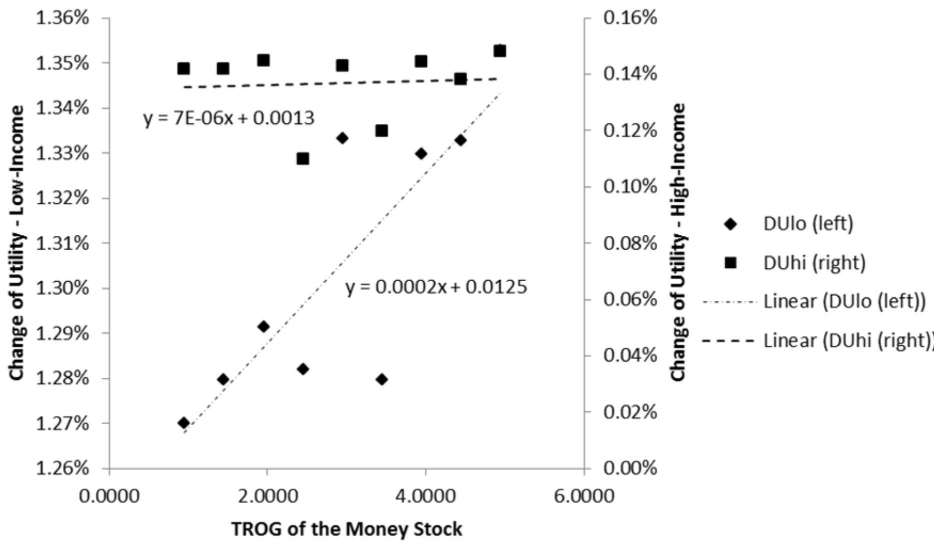


Figure 3.4.9: Expenditure Elasticities of Demand for Food through Time

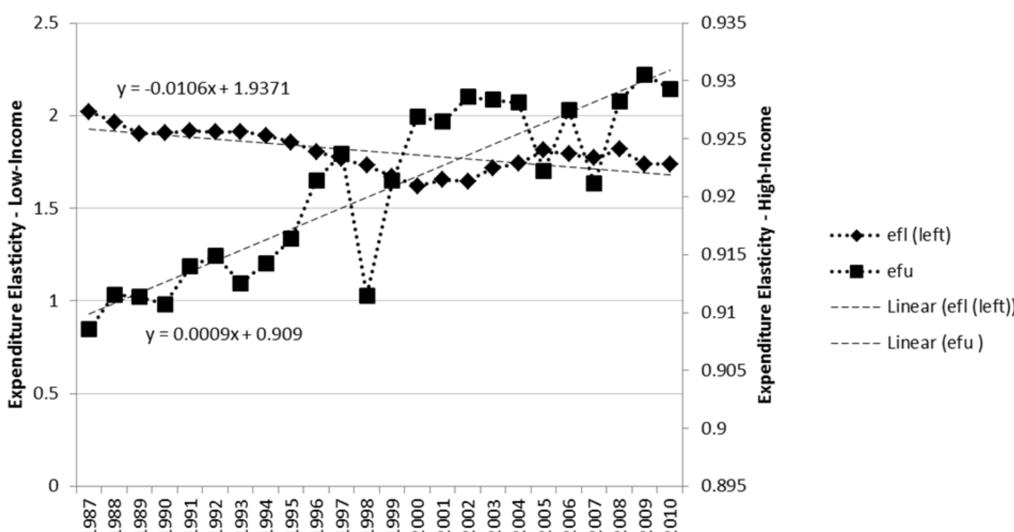


Figure 3.4.10: Expenditure Elasticities of Demand for Housing through Time

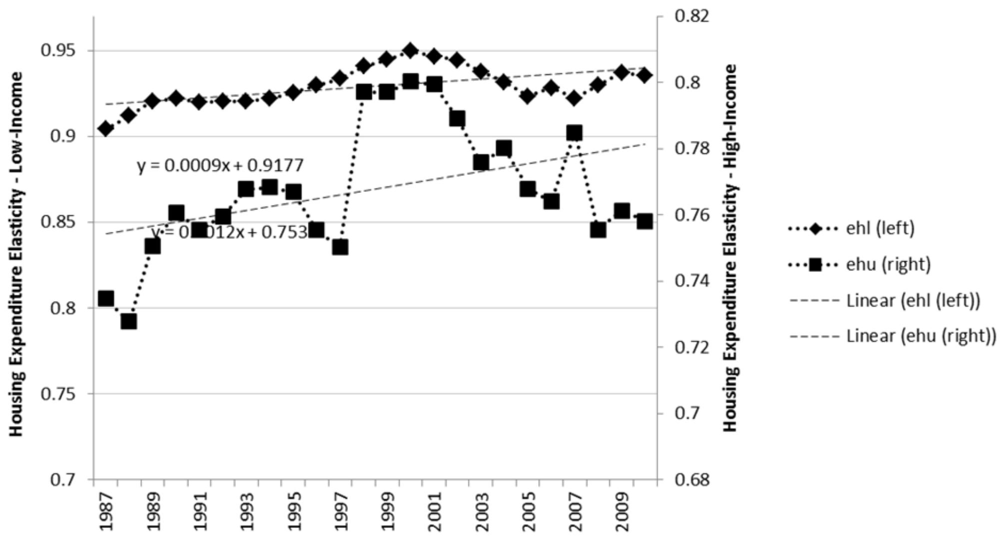


Figure 3.4.11: Own-Price Elasticities of Demand for Food through Time

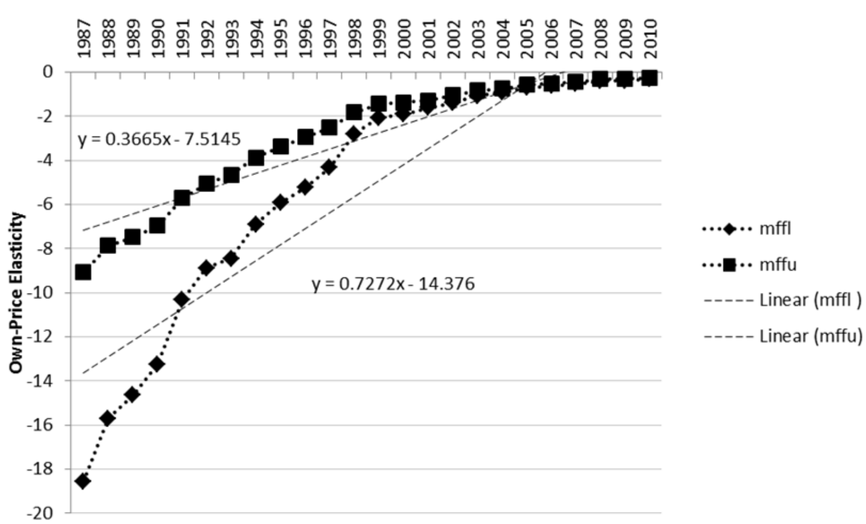


Figure 3.4.12: Own-Price Elasticities of Demand for Housing through Time

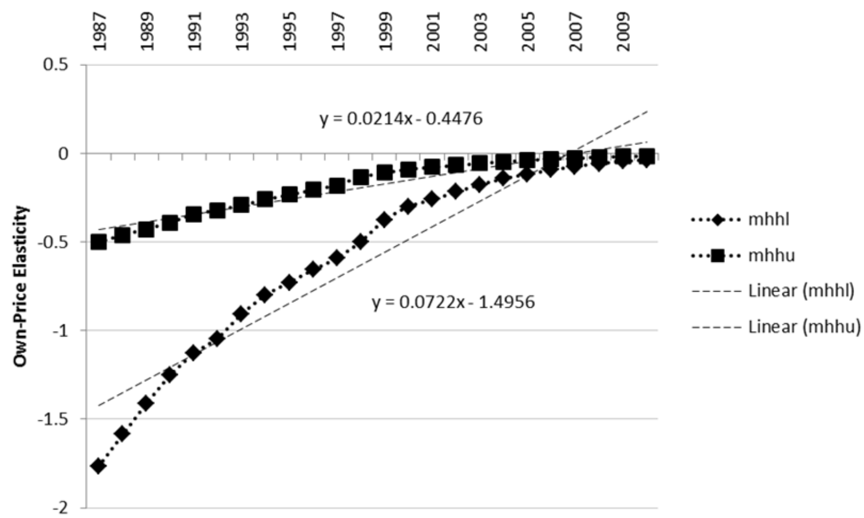


Figure 3.4.13: Cross-Price Elasticities of Demand for Food with Respect to Price of Housing through Time

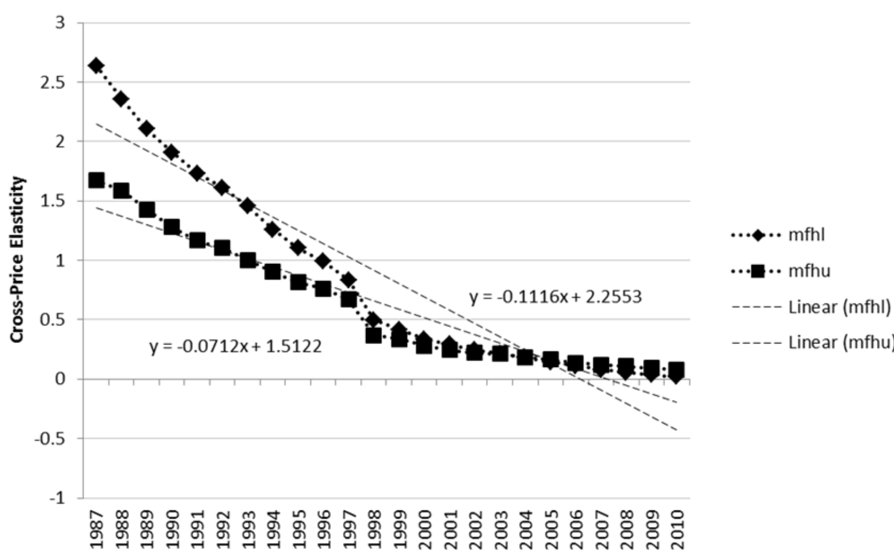


Figure 3.4.14: Cross-Price Elasticities of Demand for Housing with Respect to Price of Food through Time

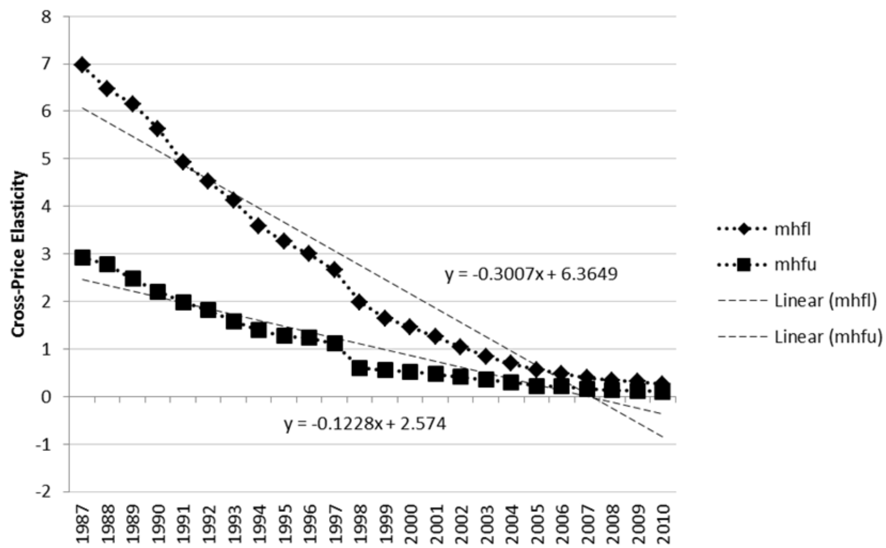


Figure 3.4.15: Simulations with Different TROG of the Money Stock (λs) and Expenditure Elasticities of Demand for Food

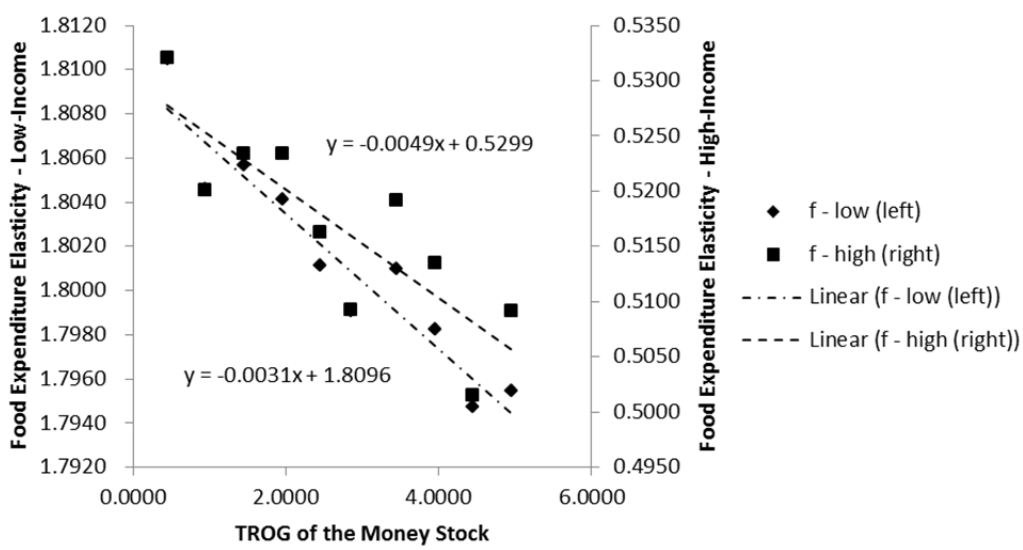


Figure 3.4.16: Simulations with Different TROG of the Money Stock (λs) and Own-Price Elasticities of Demand for Housing

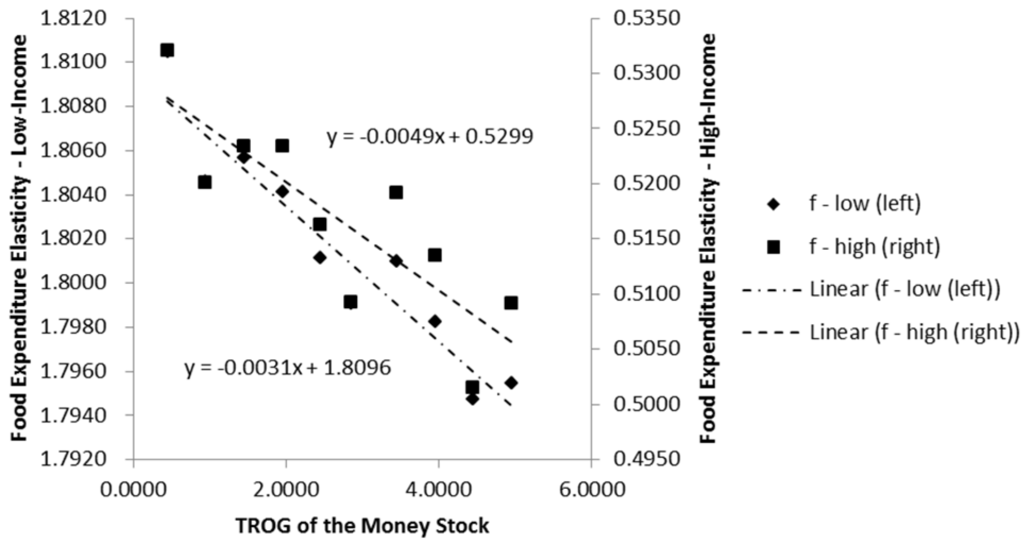


Figure 3.4.17: Simulations with Different TROG of the Money Stock (λs) and Cross-Price Elasticities of Demand for Food and Housing Prices

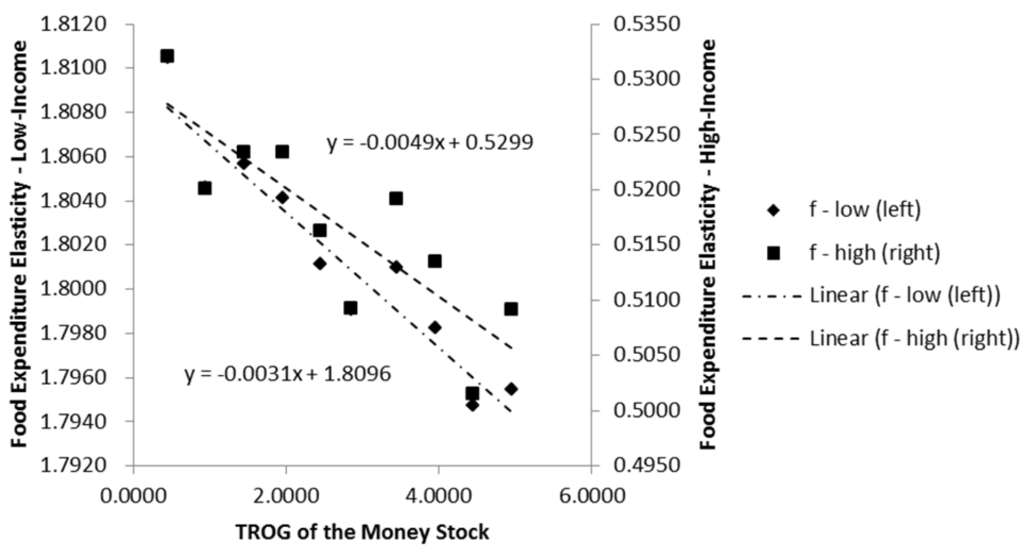
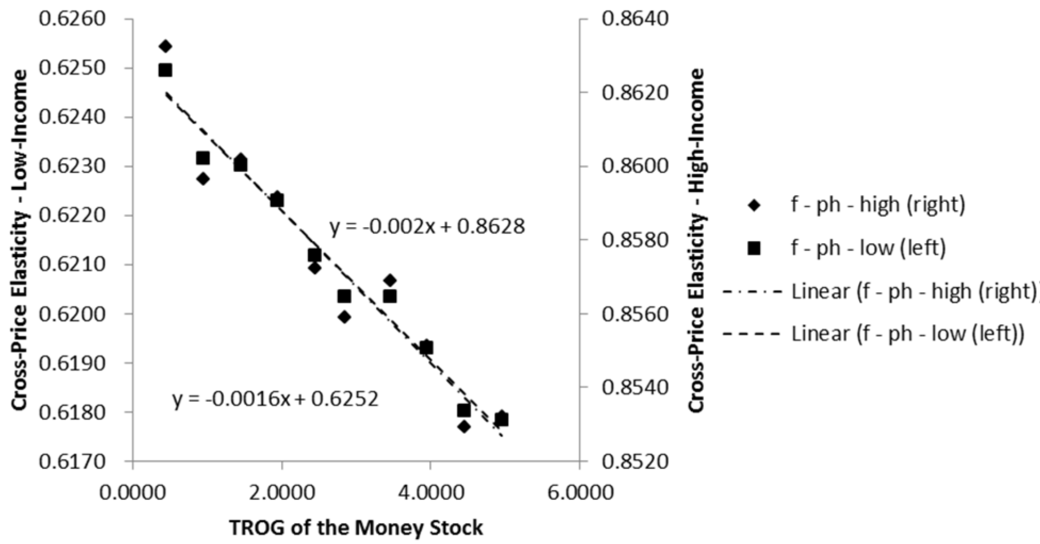


Figure 3.4.18: Simulations with Different TROG of the Money Stock (λs) and Cross-Price Elasticities of Demand for Housing and Other Commodity Prices



3.5. Discussion and Conclusion

Our findings lead us to conclude several important points. First, we have found expenditure shares for different commodities by different income groups reflect different priorities. For example, the elasticity of response of the food consumption share for the low-income groups to the changes in its own partial equilibrium consumption share is larger in proportion than elasticities of response for housing and other commodities. This is not the case for the high-income groups who put relatively almost the same weight on adjustments between food commodities and other commodities. The low-income group who have less income than those of high-income group spend the larger portion of their income on their food consumption before proceeding to consume other commodities. When relative prices change, the low-income group tends to adjust their consumption more than those of high-income group. This tendency is understandable since the same price changes might mean more in percentage toward the low-income groups than those of high-income groups.

The positive changes in the flow of financial services positively affect the adjustment of the consumption of every commodity by all income groups. This implies that the more available is money in the market, the more likely are people to consume. More specifically, when people hold more cash in their hands, they would be more likely to consume than not. The positive elasticity signs of the food consumption with respect to the financial services of both income groups show that both income groups are more likely to adjust their food consumption when they hold more cash in hands.

An increase of liquidity will positively affect housing consumption by only the high-income group, as they tend to consume more housing faster in adjusting to their equilibrium expenditure level. On the other hand, the low-income group tends to increase either food or other types of consumption and tends to slow down their consumption of housing when they have more cash in hand. This might relate to the limited amount of resources owned by the low-income groups such that they would place a higher priority on food and other commodities than on housing services.

Our empirical findings would lead one to infer that the low-income group tends to view the housing needs as part of their dreams, in the sense that when the housing prices decline and more cash becomes available, they tend to increase their expenditure on housing. The high-income group reacts in the opposite manner by minimizing the increase of their expenditure on housing when housing prices decline and more cash becomes available. This finding implies that the low-income people increase consumption of housing when they are able to afford it. This finding is also reflected in the values of computed cross-price elasticities which indicate that the low-income groups tend to increase their percentage change of their housing consumption as price of other goods increase whenever more cash becomes available.

Though it is true in terms of absolute value that the monetary policy affects the high-income group more than the low-income group, it is not true in terms of the percentage change of poor households' wealth. A change of monetary policy would affect the low-income group more than the high-income group because the low-income group suffers or benefits more because the changes represent a higher percentage of their utility than for members of the high-income group. When the policymakers only consider the effects of their policy in absolute terms, then they fail to realize that the expansion or contraction of the money supply might cause bigger impacts on low-income households.

Though it is true in terms of absolute value that the monetary policy affects the high-income group more than the low-income group, it is not true in terms of the percentage change of poor households' wealth. A change of monetary policy would affect the low-income group more than the high-income group because the low-income group suffers or benefits more as the percentage changes of their utility are larger than those of the high-income group. When the policymakers only consider the effects of their policy in absolute terms, then they fail to realize that the expansion or contraction of the money supply might cause bigger impacts on low-income households.

These results support our intuitions that the poor would be affected more by an increase or decrease of liquidity. This explains why any monetary policies such as increasing or reducing the money supply drastically would affect households' cash in hand more severely, which cause more consumption share adjustments within the low-income households.

We have shown that changes in monetary policy would affect low-income and high-income households differently, and that the effects of changes in liquidity on the expenditure patterns of different income groups also differ. If more data were available, it would be possible to estimate a model with more complete economic behaviors and including more economic agents and sectors. The limited availability of data on consumption shares in finer and longer periods than a three-year basis (before 2002) or yearly basis (from 2002 onward) prevented us from employing more equations to capture more economic behavior and tell a more complete story. The use of the MPIGLOG demand system, which for the price indices chosen ensures regularity over the entire economic region, can certainly be used to estimate the responses of different income groups.

We have shown that changes in monetary policy would affect low-income and high-income households differently, and that the effects of changes in liquidity on the expenditure patterns of different income groups also differ. If more data were available, it would be possible to estimate a model with more complete economic behaviors including more economic agents and sectors.

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APPENDIX 3A

EXPENDITURE ELASTICITIES OF DEMAND AT DIFFERENT λ

Variables	Estimated									
λ =	0.4506	0.9506	1.4506	1.9506	2.4506	2.9506	3.4506	3.9506	4.4506	4.9506
efl	1.8104	1.8045	1.8056	1.8041	1.8011	1.7990	1.8009	1.7982	1.7947	1.7954
	0.1017	0.1053	0.1028	0.1032	0.1053	0.1067	0.1019	0.1033	0.1062	0.1035
ehl	0.9285	0.9292	0.9291	0.9293	0.9296	0.9299	0.9296	0.9300	0.9304	0.9303
	0.0106	0.0111	0.0108	0.0108	0.0111	0.0113	0.0107	0.0109	0.0113	0.0109
eol	0.8403	0.8416	0.8414	0.8417	0.8424	0.8428	0.8424	0.8430	0.8438	0.8436
	0.0197	0.0205	0.0199	0.0200	0.0205	0.0209	0.0198	0.0201	0.0208	0.0202
efu	0.5321	0.5201	0.5234	0.5234	0.5162	0.5092	0.5191	0.5135	0.5015	0.5091
	0.1375	0.1422	0.1435	0.1386	0.1420	0.1498	0.1432	0.1456	0.1568	0.1473
ehu	0.9208	0.9204	0.9205	0.9205	0.9203	0.9202	0.9204	0.9203	0.9200	0.9202
	0.0072	0.0072	0.0073	0.0071	0.0071	0.0072	0.0072	0.0072	0.0073	0.0072
eou	0.7646	0.7678	0.7669	0.7676	0.7690	0.7699	0.7686	0.7699	0.7715	0.7710
	0.0180	0.0191	0.0180	0.0178	0.0193	0.0206	0.0175	0.0184	0.0207	0.0188

APPENDIX 3B

PRICE ELASTICITIES OF DEMAND AT DIFFERENT λ

Variables	Estimated									
λ =	0.4506	0.9506	1.4506	1.9506	2.4506	2.9506	3.4506	3.9506	4.4506	4.9506
mffl	(5.2531)	(5.2861)	(5.2796)	(5.2826)	(5.3018)	(5.3179)	(5.3001)	(5.3165)	(5.3442)	(5.3320)
	5.4825	5.4729	5.4867	5.4934	5.4920	5.4912	5.5136	5.5143	5.5093	5.5259
mhhl	(0.5948)	(0.5934)	(0.5932)	(0.5926)	(0.5917)	(0.5911)	(0.5910)	(0.5902)	(0.5892)	(0.5890)
	0.5220	0.5217	0.5210	0.5205	0.5201	0.5198	0.5189	0.5184	0.5181	0.5174
mool	(0.2314)	(0.2311)	(0.2310)	(0.2308)	(0.2305)	(0.2303)	(0.2302)	(0.2300)	(0.2297)	(0.2296)
	0.1798	0.1797	0.1795	0.1794	0.1793	0.1792	0.1789	0.1788	0.1787	0.1784
mfhl	0.8626	0.8602	0.8600	0.8591	0.8576	0.8565	0.8565	0.8551	0.8534	0.8531
	0.8125	0.8124	0.8112	0.8103	0.8098	0.8093	0.8076	0.8070	0.8066	0.8053
mfol	0.4702	0.4689	0.4688	0.4682	0.4674	0.4668	0.4667	0.4659	0.4650	0.4648
	0.4174	0.4174	0.4167	0.4162	0.4159	0.4157	0.4147	0.4144	0.4142	0.4135
mhol	1.2192	1.2287	1.2257	1.2263	1.2314	1.2354	1.2290	1.2332	1.2405	1.2363
	0.9694	0.9676	0.9698	0.9698	0.9693	0.9691	0.9724	0.9722	0.9715	0.9733
mhfl	2.5944	2.6065	2.6027	2.6041	2.6106	2.6156	2.6078	2.6132	2.6222	2.6175
	2.1609	2.1572	2.1607	2.1611	2.1600	2.1593	2.1648	2.1641	2.1622	2.1657
mofl	1.2513	1.2541	1.2531	1.2535	1.2550	1.2561	1.2542	1.2555	1.2575	1.2564
	1.0269	1.0257	1.0266	1.0267	1.0263	1.0260	1.0275	1.0273	1.0266	1.0276
mohl	0.9389	0.9420	0.9409	0.9412	0.9428	0.9440	0.9419	0.9432	0.9454	0.9441
	0.7712	0.7703	0.7711	0.7711	0.7709	0.7707	0.7719	0.7718	0.7714	0.7721
mffu	(2.9162)	(2.9334)	(2.9307)	(2.9337)	(2.9438)	(2.9520)	(2.9444)	(2.9532)	(2.9669)	(2.9624)
	2.7053	2.7016	2.7089	2.7124	2.7126	2.7130	2.7241	2.7252	2.7241	2.7321
mhhu	(0.1797)	(0.1800)	(0.1799)	(0.1799)	(0.1801)	(0.1802)	(0.1800)	(0.1802)	(0.1804)	(0.1803)
	0.1542	0.1541	0.1542	0.1542	0.1542	0.1541	0.1543	0.1543	0.1542	0.1543
moou	(1.1444)	(1.1374)	(1.1384)	(1.1364)	(1.1327)	(1.1302)	(1.1320)	(1.1286)	(1.1245)	(1.1249)
	0.9456	0.9470	0.9442	0.9431	0.9428	0.9424	0.9386	0.9381	0.9382	0.9355
mfhu	0.6254	0.6227	0.6231	0.6224	0.6209	0.6199	0.6207	0.6194	0.6177	0.6179
	0.5155	0.5161	0.5150	0.5146	0.5145	0.5144	0.5129	0.5128	0.5129	0.5118
mfou	1.3320	1.3269	1.3277	1.3262	1.3234	1.3214	1.3229	1.3204	1.3172	1.3176
	1.0644	1.0657	1.0636	1.0628	1.0628	1.0626	1.0597	1.0595	1.0597	1.0578
mhou	0.9664	0.9618	0.9626	0.9613	0.9589	0.9572	0.9587	0.9565	0.9537	0.9542
	0.8061	0.8070	0.8053	0.8046	0.8045	0.8043	0.8019	0.8017	0.8018	0.8001
mhfu	1.0432	1.0387	1.0394	1.0382	1.0358	1.0341	1.0355	1.0333	1.0306	1.0310
	0.8915	0.8925	0.8907	0.8900	0.8899	0.8897	0.8872	0.8870	0.8871	0.8854
mofu	2.1790	2.2013	2.1969	2.2002	2.2140	2.2259	2.2126	2.2241	2.2441	2.2355
	1.8560	1.8506	1.8588	1.8619	1.8610	1.8609	1.8737	1.8741	1.8716	1.8805
mohu	1.0288	1.0434	1.0406	1.0418	1.0509	1.0591	1.0497	1.0571	1.0710	1.0642
	0.8883	0.8857	0.8906	0.8922	0.8920	0.8923	0.8997	0.9002	0.8994	0.9042

APPENDIX 3C

INDONESIAN MODEL IN ESCONA

The Indonesian model was written in Escona which is provided by the generosity of Prof. Wymer who is the writer of the Escona program. The Escona program was designed to compute the maximum likelihood of the differential equations of the non-linear models.

```
rhol = 2 - 1.9*SIN(rholx)*SIN(rholx) $
rhou = 2 - 1.9*SIN(rhoux)*SIN(rhoux) $
plbd = 4.0 $
lbd = GEX(0.5, lbdp*lbdp) + CON*plbd $
F1 =1/ rhol $  F2 =1/ rhou $
etal = 0.3 + 0.7 - 0.7*SIN(etalp)*SIN(etalp) $
etau = 0.3 + 0.7 - 0.7*SIN(etaup)*SIN(etaup) $

betlfs = SIN(belfp)*SIN(belfp)  $
betlhs = SIN(belhp)*SIN(belhp)  $
betlos = SIN(belop)*SIN(belop) $

betufs = SIN(beufp)*SIN(beufp) $
betuhs = SIN(beuhp)*SIN(beuhp) $
betuos = SIN(beuop)*SIN(beuop) $

bcl = etal/(betlfs + betlhs + betlos) $
bcu = etau/(betufs + betuhs + betuos) $

betlf = bcl * betlfs $
betlh = bcl * betlhs $
betlo = bcl * betlos $

betuf = bcu * betufs $
betuh = bcu * betuhs $
betuo = bcu * betuos $

F3= betlf + betlh + betlo $
F4 = betuf + betuh + betuo $

philf = GEX(0.5, pilfp*pilfp)  $
philh = GEX(0.5, pilhp*pilhp)  $
philo = GEX(0.5, pilop*pilop)  $

phiuf= GEX(0.5, piufp*piufp)   $
phiuh= GEX(0.5, piuhp*piuhp)   $
phiuo= GEX(0.5, piuop*piuop)   $
```

```
Vp1lr = philf * GEX(-rhol,pf) + philh * GEX(-rhol,ph) + philo * GEX(-rhol,po) $
Vp1l = GEX(-F1,Vp1lr) $

Vp1ur = phiuf * GEX(-rhou,pf) + phiuh * GEX(-rhou,ph) + phiuo *GEX(-rhou, po) $
Vp1u = GEX(-F2,Vp1ur) $

Vzld = 1.0 + F3 *cl - F3 * LOG(Vp1l) $
Vzl = F3 *cl / Vzld - F3 * LOG(Vp1l) / Vzld $

Vzud = 1.0 + F4 *cu - F4 * LOG(Vp1u) $
Vzu = F4 *cu / Vzud - F4 * LOG(Vp1u) / Vzud $

Vpflr = Vp1l /  pf $
Vphlr = Vp1l /  ph $
Vpolr = Vp1l /  po $

Vpfur = Vp1u /  pf $
Vphur = Vp1u / ph $
Vpour = Vp1u /  po $

Vslf = philf * GEX(rhol,Vpflr) * (1 - Vzl) + betlf * Vzl / F3 $
Vslh = philh * GEX(rhol,Vphlr) * (1 - Vzl) + betlh * Vzl / F3 $
Vslo = 1-Vslf-Vslh  $

Vsuf = phiuf * GEX(rhou,Vpfur) * (1 - Vzu) + betuf * Vzu / F4 $
Vsuh = phiuh * GEX(rhou,Vphur) * (1 - Vzu) + betuh * Vzu / F4 $
Vsuo = 1-Vsuf-Vsuh  $

Vx1=Vslf+Vslh+Vslo  $  Vx2=Vsuf+Vsuh+Vsuo  $

tx3=philf + philh + philo $  tx4=phiuf + phiuh + phiuo $
tx5=betlf + betlh + betlo $  tx6=betuf + betuh + betuo $

COL = ib * EXP(cc) + (ib - ica) * ca + (ib - iqm) * qm $

VDLFS = ( ib * EXP(cc) / COL) * cc1 + (ib - ica)*ca*ca1/COL + (ib - iqm) * qm*qm1/COL $

gm11 = GEX(0.5,gam11*gam11) $
gm22 = GEX(0.5, gam22*gam22) $

gm41 = GEX(0.5,gam41*gam41) $
gm52 = GEX(0.5, gam52*gam52) $

gm6 = GEX(0.5, gam6*gam6) $
bt1 = GEX(0.5, bet1*bet1) $
bt2 = GEX(0.5, bet2*bet2) $

Vclet = GEX(F3, EXP(cl)) $
Vcuet = GEX(F4, EXP(cu)) $
```

```
Vp2l = GEX(betlf,pf)*GEX(betlh,ph)*GEX(betlo,po) $
Vp2u = GEX(betuf,pf)*GEX(betuh,ph)*GEX(betuo,po) $

Vul = (cl - LOG(Vp1l))*(Vclet/Vp2l) $
Vuu = (cu - LOG(Vp1u))*(Vcuet/Vp2u) $

Ve1ffl = philf*philf* rhol*GEX(F1-2,Vp1lr)*GEX(-rhol,pf)*GEX(-rhol,pf) $
Ve1hhl = philh*philh*rhol*GEX(F1-2,Vp1lr)*GEX(-rhol,ph)*GEX(-rhol,ph) $
Ve1ool = philo*philo/tx3*rhol*GEX(F1-2,Vp1lr)*GEX(-rhol,po)*GEX(-rhol,po) $

Ve1fhl = philf*philh*rhol*GEX(F1-2,Vp1lr)*GEX(-rhol, pf*ph) $
Ve1fol = philf*philo*rhol*GEX(F1-2,Vp1lr)*GEX(-rhol, pf*po) $
Ve1hol = philh*philo*rhol*GEX(F1-2,Vp1lr)*GEX(-rhol, ph*po) $

Ve1ffu = phiuf*phiuf*rhou*GEX(F2-2,Vp1ur)*GEX(-rhou,pf)*GEX(-rhou,pf) $
Ve1hhu = phiuh*phiuh*rhou*GEX(F2-2,Vp1ur)*GEX(-rhou,ph)*GEX(-rhou,ph) $
Ve1oou = phiuo*phiuo*rhou*GEX(F2-2,Vp1ur)*GEX(-rhou,po)*GEX(-rhou,po) $

Ve1fhu = phiuf*phiuh*rhou*GEX(F2-2,Vp1ur)*GEX(-rhou, pf*ph) $
Ve1fou = phiuf*phiuo*rhou*GEX(F2-2,Vp1ur)*GEX(-rhou, pf*po) $
Ve1hou = phiuh*phiuo*rhou*GEX(F2-2,Vp1ur)*GEX(-rhou, ph*po) $

Vefl = 1 + (betlf / (slf - F3))*(1 - Vzl) $
Vehl = 1 + (betlh / (slh - F3))*(1 - Vzl) $
Veol = 1 + (betlo / (1-slf-slh - F3))*(1 - Vzl) $

Vefu = 1 + (betuf / (suf - F4))*(1 - Vzu) $
Vehu = 1 + (betuh / (suh - F4))*(1 - Vzu) $
Veou = 1 + (betuo / (1-suf - suh - F4))*(1 - Vzu) $

Vmffl = (Ve1ffl * (1 - Vzl) - betlf * philf * (1 - Vzl)) / (slf - 1 + F3 * philf * (1  - Vzl)) $
Vmhhl = (Ve1hhl * (1 - Vzl) - betlh * philh * (1 - Vzl)) / (slh - 1 + F3 * philh * (1 - Vzl)) $
Vmool = (Ve1ool * (1 - Vzl) - betlo * philo * (1 - Vzl)) / (1 - slf - slh - 1 + F3 * philo * (1 - Vzl)) $

Vmfhl = (Ve1fhl * (1 - Vzl) - betlf * philh * (1 - Vzl)) / (slf + F3 * philh * (1 - Vzl)) $
Vmfol = (Ve1fol * (1 - Vzl) - betlf * philo * (1 - Vzl)) / (slf + F3 * philo * (1 - Vzl)) $

Vmhol = (Ve1hol * (1 - Vzl) - betlh * philo * (1 - Vzl)) / (slh + F3 * philo * (1 - Vzl)) $
Vmhfl = (Ve1fhl * (1 - Vzl) - betlh * philf * (1 - Vzl)) / (slh + F3 * philf * (1 - Vzl)) $

Vmofl = (Ve1fol * (1 - Vzl) - betlo * philf * (1 - Vzl)) / (1-slh-slf + F3 * philf * (1 - Vzl)) $
Vmohl = (Ve1hol * (1 - Vzl) - betlo * philh * (1 - Vzl)) / (1-slh-slf + F3 * philh * (1 - Vzl)) $

Vmffu = (Ve1ffu * (1 - Vzu) - betuf * phiuf * (1 - Vzu)) / (suf - 1 + F4 * phiuf * (1 - Vzu)) $
Vmhhu = (Ve1hhu * (1 - Vzu) - betuh * phiuh * (1 - Vzu)) / (suh - 1 + F4 * phiuh * (1 - Vzu)) $
Vmoou = (Ve1oou * (1 - Vzu) - betuo * phiuo * (1 - Vzu)) / (1 - suf - suh - 1 + F4 * phiuo * (1 - Vzu)) $

Vmfhu = (Ve1fhu * (1 - Vzu) - betuf * phiuh * (1 - Vzu)) / (suf + F4 * phiuh * (1 - Vzu)) $
Vmfou = (Ve1fou * (1 - Vzu) - betuf * phiuo * (1 - Vzu)) / (suf + F4 * phiuo * (1 - Vzu)) $
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Vmhou = (Ve1hou * (1 - Vzu) - betuh * phiuo * (1 - Vzu)) / (suh + F4 * phiuo * (1 - Vzu)) $
Vmhfu = (Ve1fhu * (1 - Vzu) - betuh * phiuf * (1 - Vzu)) / (suh + F4 * phiuf * (1 - Vzu)) $

Vmofu = (Ve1fou * (1 - Vzu) - betuo * phiuf * (1 - Vzu)) / (1-suh-suf + F4 * phiuf * (1 - Vzu)) $
Vmohu = (Ve1hou * (1 - Vzu) - betuo * phiuh * (1 - Vzu)) / (1-suh-suf + F4 * phiuh * (1 - Vzu)) $

EQN1: Dslf= gm11*Vslf -gm11*slf +gam12*Vslh -gam12*slh +gam13*Vslo -gam13*(1-slf-slh)
+gam14*VDLFS $

EQN2: Dslh= gam21*Vslf -gam21*slf +gm22*Vslh -gm22*slh +gam23*Vslo -gam23*(1-slf-slh)
+gam24*VDLFS $

EQN3: Dsuf= gm41*Vsuf -gm41*suf +gam42*Vsuh -gam42*suh +gam43*Vsuo -gam43*(1-suf-suh)
+gam44*VDLFS $

EQN4: Dsuh= gam51*Vsuf -gam51*suf +gm52*Vsuh -gm52*suh +gam53*Vsuo -gam53*(1-suf-suh)
+gam54*VDLFS $

EQN5: Dcc1 = gm6*Ibd*Ko + gm6*bt1*gdf1 + gm6*bt1*gdpr1 - gm6*bt2*ib - gm6*cc1 $

EQN6: Dcl = bet31*gdpr1 + bet31*gdf1 + bet32*cc1 $

EQN7: Dcu = bet41*gdpr1 + bet41*gdf1 + bet42*cc1 $

EQN8: Dcc = cc1 $

EQN9: ulo = Vul $

EQN10: uhi = Vuu $

EQN11: efl = Vefl $

EQN12: ehl = Vehl $

EQN13: eol = Veol $

EQN14: efu = Vefu $

EQN15: ehu = Vehu $

EQN16: eou = Veou $

EQN17: mffl = Vmffl $

EQN18: mhhl = Vmhhl $

EQN19: mool = Vmool $

EQN20: mfhl = Vmfhl $
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EQN21: mfol = Vmfol $

EQN22: mhol = Vmhol $

EQN23: mhfl = Vmhfl $

EQN24: mofl = Vmofl $

EQN25: mohl = Vmohl $

EQN26: mffu = Vmffu $

EQN27: mhhu = Vmhhu $

EQN28: moou = Vmoou $

EQN29: mfhu = Vmfhu $

EQN30: mfou = Vmfou $

EQN31: mhou = Vmhou $

EQN32: mhfu = Vmhfu $

EQN33: mofu = Vmofu $

EQN34: mohu = Vmohu $